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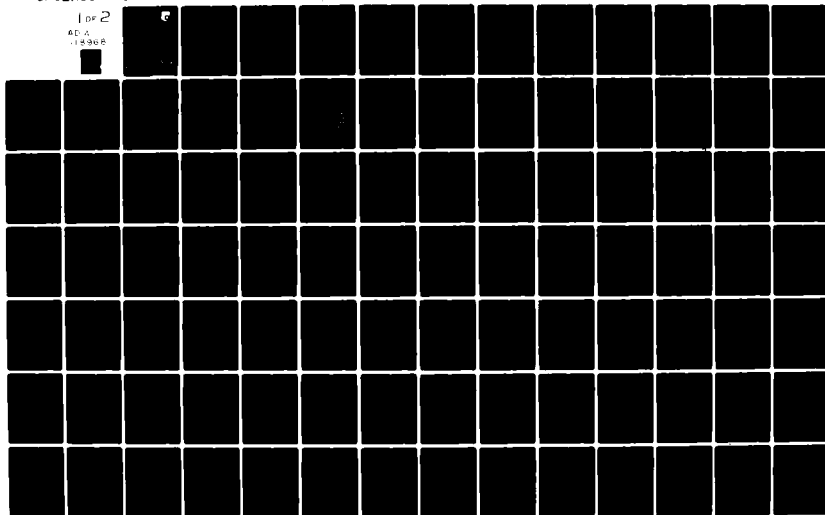
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VOLUME I



A USER'S MANUAL FOR A DETAILED LEVEL FATIGUE
CRACK GROWTH ANALYSIS COMPUTER CODE,
VOLUME I — THE CRKGRO PROGRAM

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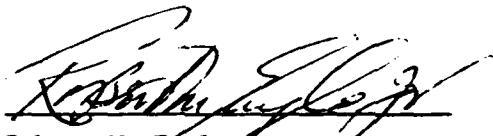
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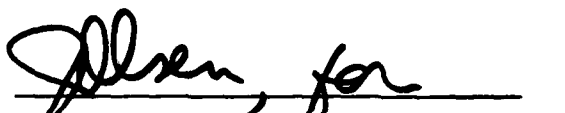
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containing a specific stress intensity factor solution for a specific crack geometry. The program provides the option for counting the cycles for spectrum loadings through the range-pair counting routine built into the program. It also provides the option to perform parametric studies. ~

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FOREWORD

This report presents the description of a computer code which was developed to perform detailed fatigue crack-growth analysis on a cycle-by-cycle basis. This computer code is a two-dimensional crack-growth analysis routine. An improved load interaction model which accounts for both the tensile overload retardation and compressive load acceleration effects of a spectrum loading has been implemented in this program. The development effort of this computer code was under Air Force Contract F33615-77-C-3121, Project 2401, "Structural Mechanics," Task 240101, "Structural Integrity for Military Aerospace Vehicles," Work Unit 24010120, entitled "Improved Methods for Predicting Spectrum Loading Effects." This contract was administered by the Flight Dynamics Laboratory of the Air Force Wright Aeronautical Laboratories, Wright-Patterson Air Force Base, Ohio. R.M. Engle (AFWAL/FIBE) was the Air Force project engineer

This development effort was conducted by personnel from the Fatigue and Fracture Mechanics Group, Dynamics Technology, Structure Systems, under the direction of George Fitch, Jr., supervisor, Joseph S. Rosenthal, manager, and Dr. Leslie M. Lackman, director. James B. Chang was the program manager and principal investigator. Edward Klein was the original developer of this computer code.



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Section I

INTRODUCTION

This document describes a computer program which was developed to perform detailed fatigue crack growth analysis on a cycle-by-cycle basis. The fatigue crack growth prediction method incorporated in this computer code is an improved methodology based on state-of-the-art technologies. The development effort and correlation of the analytical predictions to the test data were documented in reference 1.

The baseline fatigue crack growth rate equation chosen in the program was the modified Walker equation (reference 2) with variable threshold stress intensity factor range. The generalized Willenborg retardation model (reference 3) and the Chang acceleration scheme (reference 4) were selected to handle the complex load interaction effects in a spectrum loading which include tensile overload retardation, and faster crack growth caused by the existence of the compressive load in compression-tension (negative stress ratio) cycles.

Reduction of the overload retardation effect when the overload is followed by a compression load is also accounted for using a reduction of the effective overload plastic zone size approach formulated by Chang (reference 1). The linear approximation method proposed by Vroman which was widely used in existing computer programs such as EFFGRO (reference 5) and CRACKS (reference 6) was adopted as the damage accumulation scheme. To account for the shape-change effect of a part-through crack (PTC), such as the surface flaw and a single corner crack at a fastener hole, the two-dimension (2-D) crack growth analysis approach used by many existing crack growth codes, including Rockwell's FLAGRO (reference 7) and NASA's CRACK (reference 8), was adopted in this computer program. The 2-D crack-growth-analysis approach assumes that growth in the two principal directions of a part-through crack is a function of the stress intensity factors at the extreme points in each direction. The CRKGRO program also provides the 1-D crack-growth-analysis option for the part-through cracks.

A collection of stress-intensity-factor solutions for various through-crack (TC) and PTC configurations has been incorporated into this program through a CRACK LIBRARY module which consists of 10 subroutines, each containing a specific stress-intensity-factor solution for a specific crack geometry. There are eight additional dummy routines stored in the program, which provides the user the capability for adding new stress-intensity-factor solutions for the crack geometries needed to be considered.

The program provides the option for counting the cycles for spectrum loadings through the range-pair counting routine built into the program. The program also provides the option to perform parametric studies on parameters which dominate the degree of damage such as the design limit stresses.

The CRKGRO program also provides four options for presenting the crack growth history in graphical plotting format. These options are (1) crack size versus number of flights, a versus N , (2) crack growth rates versus number of flights, da/dF versus N , (3) crack growth rate versus crack sizes, da/dF versus a , and (4) crack growth rate versus the maximum stress intensity factor per flight, da/dF versus K_{max} . For a parametric study, a maximum of seven curves can be plotted on one chart in order to provide the user a clear picture.

Section II

TECHNICAL DISCUSSION

The technical approach used in this computer program is applicable primarily for metallic structures which contain cracks or crack-like flaws subjected to cyclic loadings. The crack growth analysis methodology was developed based on linear elastic fracture mechanics (LEFM) principles; i.e., the range of crack-tip stress intensity factor, ΔK , is the controlling parameter for characterizing the cyclic crack growth rates.

This section includes a discussion of each of the following elements which form the overall analysis methodology incorporated in the program: fatigue crack-growth-rate equation, load interaction model, damage accumulation scheme, and stress-intensity-factor solutions.

FATIGUE CRACK-GROWTH-RATE EQUATION

For constant-amplitude loadings, the baseline fatigue crack-growth-rate equations used in this program are the modified Walker equation (reference 2) for positive stress ratios and the Chang equation (reference 4) for negative stress ratios. In mathematical forms, they can be expressed as follows:

For $\Delta K > \Delta K_{th}$, $R \geq 0$

$$da/dN = C [\Delta K / (1 - \bar{R})^{1-m}]^n, \quad \bar{R} \leq R_{cut}^+, \bar{R} = R$$
$$\bar{R} > R_{cut}^+, \bar{R} = R_{cut}^+$$

For $\Delta K > \Delta K_{th}$, $R < 0$

$$da/dN = C [(1 + \bar{R}^2)^q K_{max}]^n, \quad \bar{R} \geq R_{cut}^-, \bar{R} = R$$
$$\bar{R} < R_{cut}^-, \bar{R} = R_{cut}^-$$

For $\Delta K \leq \Delta K_{th}$

$$da/dN = 0$$

where C and n are the growth rate constants; m is the stress-ratio collapsing factor, q is the acceleration exponent, and R_{cut}^{\pm} are the cutoff values for the stress ratios, either positive or negative.

The threshold stress-intensity-factor range ΔK_{th} is determined by

$$\Delta K_{th} = (1 - AR) \Delta K_{th_0}$$

where ΔK_{th_0} is the threshold value of the stress-intensity-factor range obtained from $R = 0$ constant amplitude tests; A is an empirical constant determined from constant-amplitude test data with various stress ratios.

A detailed description on the procedure for the determination of the crack-growth-rate constants is in Appendix A.

LOAD INTERACTION MODEL

Various load interaction effects on the crack growth behavior under spectrum loadings have been observed. The important effects are:

1. Tensile overloads cause significant retardation of the crack growth.
2. Compressive loads accelerate crack growth rates. Furthermore, a compressive load immediately following the tensile overload reduces the retardation effect introduced by the tensile overload.

TENSILE OVERLOAD RETARDATION MODEL

To account for the retardation effect, the generalized Willenborg model (reference 3) is adopted in this program. The generalized Willenborg model can be written in the following form:

$$(K_{max})_{eff} = K_{\infty max} - \Phi \left[K_{max}^{OL} \left(1 - \frac{\Delta a}{Z_{OL}} \right)^{1/2} - K_{\infty max} \right]$$

$$(K_{min})_{eff} = K_{\infty min} - \Phi \left[K_{max}^{OL} \left(1 - \frac{\Delta a}{Z_{OL}} \right)^{1/2} - K_{\infty max} \right]$$

$$\Phi = [1 - (K_{max_{TH}} / K_{\infty max})] / (R_{SO} - 1)$$

where $K_{\infty max}$ is the stress-intensity-factor corresponding to the maximum remotely applied stress, K_{max}^{OL} is the stress-intensity-factor corresponding to the maximum stress of the overload, Δa is the incremental growth following

the overload, Z_{OL} is the overload interaction zone size. R_{SO} is the overload shutoff ratio which is defined as:

$$R_{SO} = K_{max}^{OL} / K_{max}^{\infty}$$

For spectrum loading, the effective stress-intensity-factor range and effective stress ratio which are used in CRKGRO, are expressed in terms of the maximum and minimum effective stress intensity factors as follows:

$$\Delta K_{eff} = (K_{max})_{eff} - (K_{min})_{eff}$$

$$R_{eff} = (K_{min})_{eff} / (K_{max})_{eff}$$

In the load-interaction-accounted-for option, the program utilizes the following equation to account for tensile overload retardation effect:

For $\Delta K_{eff} > \Delta K_{th}$, $R_{eff} \geq 0$

$$da/dN = C [(\Delta K)_{eff} / (1 - \bar{R}_{eff})^{1-m}]^n, \bar{R}_{eff} \leq R_{cut}^+, \bar{R}_{eff} = R_{eff}$$

$$\bar{R}_{eff} > R_{cut}^+, \bar{R}_{eff} = R_{cut}^+$$

For $\Delta K_{eff} \leq \Delta K_{th}$

$$da/dN = 0$$

where C , n , m and R_{cut}^+ are the same crack-growth-rate parameters described under "Fatigue Crack-Growth-Rate Equation." The threshold values of the stress-intensity-factor range are also identical to those used in the constant-amplitude cases.

COMPRESSIVE LOAD ACCELERATION MODEL

If the effective stress ratio is negative; i.e., $R_{eff} < 0$, the Chang negative stress ratio equation is used in this program, which accounts for the compressive load acceleration effect:

$$da/dN = C [(1 + \bar{R}_{eff}^2)^q (K_{max})_{eff}]^n, \bar{R}_{eff} \geq R_{cut}^-, \bar{R}_{eff} = R_{eff}$$

$$\bar{R}_{eff} < R_{cut}^-, \bar{R}_{eff} = R_{cut}^-$$

where q is the acceleration index determined from test data generated for a specific negative stress ratio ($R < 0$) and its $R = 0$ counterpart.

The reduction of the overload retardation effect caused by a compressive spike load immediately following the tensile overload is accounted for by CRKGRO through an effective overload interaction zone concept proposed by Chang (reference 1). The effective overload interactive zone is defined in terms of the negative effective stress ratio ($R_{eff} < 0$) as:

$$(Z_{oL})_{eff} = (1 + \bar{R}_{eff}) (Z_{oL}), \bar{R}_{eff} \geq R_{cut}^-, \bar{R}_{eff} = R_{eff}$$

$$\bar{R}_{eff} < R_{cut}^-, \bar{R}_{eff} = R_{cut}^-$$

where Z_{oL} is the plastic zone size introduced by the tensile overload.

In CRKGRO, the plane strain plastic zone size is used if the stress intensity factor at the maximum depth for a part-through crack is to be calculated. The plane stress plastic zone size is used at the length direction for TC's and PTC's. The plane stress and plane strain plastic zone sizes are:

$$(Z_{oL})_{plane\ strain} = \frac{1}{6\pi} \left(\frac{K_{\infty max}}{F_{ty}} \right)^2$$

$$(Z_{oL})_{plane\ stress} = \frac{1}{2\pi} \left(\frac{K_{\infty max}}{F_{ty}} \right)^2$$

where F_{ty} is the material tensile yield strength.

DAMAGE ACCUMULATION SCHEME

The Vroman linear approximation method has been incorporated into this computer program as the damage accumulation scheme. The following paragraphs briefly describe the method.

For a given load spectrum as shown in table 1, the Vroman damage accumulation scheme proceeds by considering a load step (i) and using σ_{max_i} and σ_{min_i} to calculate $(da/dN)_i$. The value of $(0.01a)/(da/dN)_i$ is then compared to N_i , where "a" is the instantaneous crack size. If $(0.01a)/(da/dN)_i$ is greater than N_i , then the crack growth for that particular load step is $\Delta a = N_i \times (da/dN)_i$, the crack has then grown from "a" to $(a + \Delta a)$, and the program proceeds to the next load step.

If $(0.01a)/(da/dN)_i$ is less than or equal to N_i , the crack size will be $(a + 0.01a)$, and this load step is reexamined. This process continues with $(0.01a)/(da/dN)_i$ being compared to the remaining cycles in the step. When all load steps in the block or flight have been examined, the program then proceeds to the first step of the next block (or flight) and continues.

TABLE 1. A TYPICAL STRESS SPECTRUM TABLE (SCHEMATIC)

Step	Max stress	Min stress	No. of cyc/ block (flight)
1	σ_{\max_1}	σ_{\min_1}	N_1
2	σ_{\max_2}	σ_{\min_2}	N_2
3	σ_{\max_3}	σ_{\min_3}	N_3
.	.	.	.
.	.	.	.
.	.	.	.
i	σ_{\max_i}	σ_{\min_i}	N_i

STRESS-INTENSITY-FACTOR SOLUTIONS

Two major types of crack geometry are considered in this program: TC and PTC. Crack-tip stress-intensity-factor solutions for commonly detected TC and PTC are incorporated into the CRACK LIBRARY module of this program. The CRACK LIBRARY module consists of separate subroutines, each containing one set of stress-intensity-factor solution.

For PTC's, this program accounts for the shape-change effects through the 2-D crack-growth-analysis approach. The 2-D crack-growth-analysis approach assumes that growth in the two principal directions of a PTC can be characterized by the stress-intensity-factors at the extreme points of each direction. In constant-amplitude loadings for example, the crack growth rates at the two extreme points, A and B, of a surface crack as shown in Figure 1 are calculated by CRKGRO using the following set of equations:

$$da/dN = C_A [\Delta K_A / (1 - R)]^{1-m_A} n_A$$

$$dc/dN = C_B [\Delta K_B / (1 - R)]^{1-m_B} n_B$$

where C_A , n_A , m_A and C_B , n_B , m_B are the material's crack-growth-rate parameters along the depth and the length directions, respectively; R is the cyclic stress ratio, and ΔK_A and ΔK_B are the stress-intensity-factor range at the maximum depth and length points, respectively.

The stress intensity factors at the maximum depth point A, and the maximum length point B built into CRKGRO are prepared using the compound solution format. In general, these can be expressed as:

$$K_A = \left[F_A \left(\frac{a}{t}, \frac{a}{c}, \frac{c}{b} \right) \right] \sigma \sqrt{\frac{\pi a}{Q}} \quad \text{at the maximum depth}$$

$$K_B = \left[F_B \left(\frac{a}{t}, \frac{a}{c}, \frac{c}{b}, \frac{a}{c} \right) \right] \sigma \sqrt{\frac{\pi c}{Q}} \quad \text{at the maximum length}$$

where a is the depth, c is the half-length for a surface crack, t is the thickness of the structure, b is the half-width of the structure, Q is the shape factor, and F_A and F_B are the geometrical magnification factors for the maximum depth point A and the maximum length point B as shown in Figure 1.

In CRKGRO, the geometrical magnification factors are in a polynomial format. For the surface crack shown in figure 1, the geometrical magnification factors are derived from the general surface crack stress-intensity-factor solution proposed by Newman (reference 9). At point B, the solution was derived from $\phi = 10^\circ$ as suggested by Newman (Reference 12).

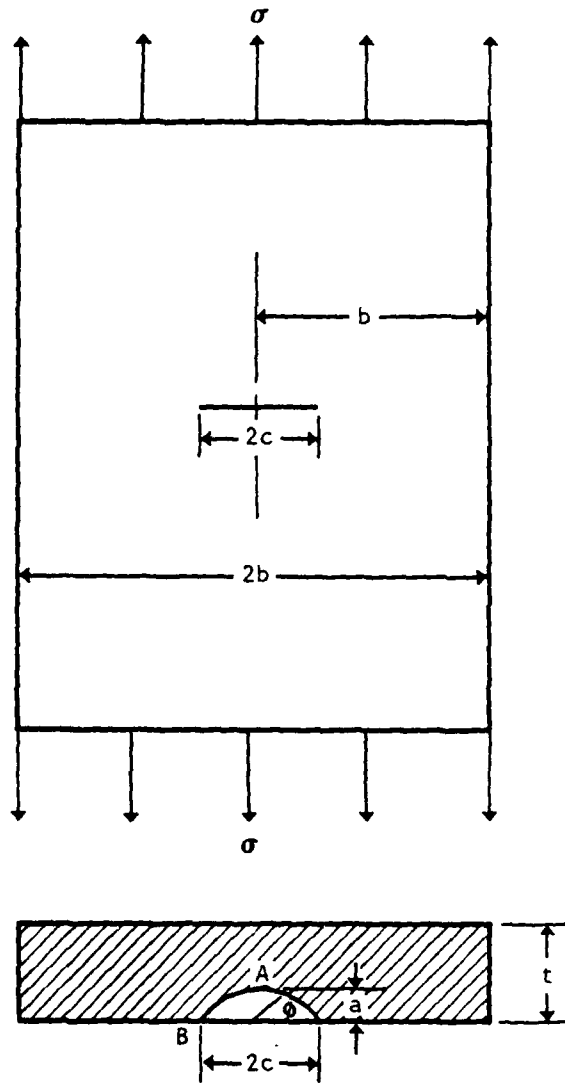


Figure 1. A Typical Surface Crack Configuration

At point A ($\phi = 90^\circ$)

$$F_A = \left\{ 1.13 - 0.09 (a/c) + \left[\frac{0.89}{(0.2 + a/c)} - 0.54 \right] \left(\frac{a}{t} \right)^2 \right. \\ \left. + \left[0.5 - \frac{1}{(0.65 + a/c)} + 14 (1 - a/c)^{24} \right] \left(\frac{a}{t} \right)^4 \right\} \\ \times \left[\sqrt{\sec\left(\frac{\pi c}{2b} \sqrt{\frac{a}{t}}\right)} \right]$$

At point B, ($\phi = 10^\circ$)

$$F_B = \left\{ 1.13 - 0.09(a/c) + \left[\frac{0.89}{(0.2 + a/c)} - 0.54 \right] \left(\frac{a}{t} \right)^2 \right. \\ \left. + \left[0.5 - \frac{1}{(0.65 + a/c)} + 14 (1 - a/c)^{24} \right] \left(\frac{a}{t} \right)^4 \right\} \\ \times \left\{ \left[1.1 + 0.35(a/t)^2 \right] \left(\frac{a}{c} \right) \sqrt{\sec\left(\frac{\pi c}{2b} \sqrt{\frac{a}{t}}\right)} \right\}$$

The shape factor Q used in CRKGRO is also in a closed-form solution format which was formulated by Newman (reference 10) as:

$$Q = (1 + 1.464 (a/c)^{1.65})$$

A collection of stress-intensity-factor solutions for various TC and PTC configurations has been incorporated into CRKGRO through a CRACK LIBRARY module which consists of separate subroutines, each containing one stress-intensity-factor solution. A crack code system is used in CRKGRO. Figure 2 shows the crack geometries with the corresponding assigned code number. For example, crack code 1010 is the surface flaw and 2010 is the centered TC. Each PTC subroutine has two sets of solutions, K_A and K_B . The stress intensity factor for a shallow crack ($a/c \leq 1$) and for a deep crack ($a/c > 1$) are included in the same subroutine. Ten stress-intensity-factor solutions have been incorporated in the CRACK LIBRARY module. Appendix B contains these solutions.

For part-through cracks, the CRKGRO program also provides the one-dimensional (1-D) crack growth analysis options. For the 1-D option, only the stress intensity factor at the maximum depth of a PTC is calculated. The aspect ratio ($a/2c$) is assumed to be constant through the whole period of the growth of the PTC, i.e., the shape change of a PTC is not accounted for in the crack growth analysis.

The 1-D stress intensity factor solutions for various part-through cracks such as the surface crack, the edge corner crack, are presented also in Appendix B. These solutions are somewhat different than its 2-D option counterpart due to the fact that the shape change effect is not accounted for in the 1-D option, they were formulated using the compound solution technique with the average value using for geometry correction factor.










CODE NO.	DESCRIPTION	GEOMETRY
1010	SURFACE CRACK, CENTERED	
1030	ONE CORNER CRACK FROM CENTERED OPEN HOLE	
1050	TWO CORNER CRACKS FROM CENTERED OPEN HOLE	
1070	ONE CORNER EDGE CRACK	
2010	THROUGH-CRACK, CENTERED	
2020	ONE THROUGH-CRACK FROM CENTERED OPEN HOLE	
2030	TWO THROUGH-CRACKS FROM CENTERED OPEN HOLE	
2040	ONE THROUGH-EDGE CRACK	
2050	TWO THROUGH-EDGE CRACKS	
2060	ASTM COMPACT SPECIMEN	

Figure 2. Crack Library

Section III

PROGRAM OUTLINES

This computer code is called a detail crack growth analysis program and its identification is CRKGRO. A program flowchart is shown in figure 3. CRKGRO consists of 34 subroutines, of which 18 are basic to the stress-intensity-factor calculations identified as the CRACK LIBRARY. Currently, 10 stress-intensity-factor solutions have been incorporated into CRKGRO. Appendix B shows these 10 stress-intensity-factor solutions. The other eight subroutines are the dummy subroutines, in which a new stress-intensity-factor solution can be coded into the program.

1. CRKGRO - overall supervisory routine
2. CENTER - centers titles with assigned fields
3. CICON - converts characters to binary
4. CMBCD - moves BCD characters from one FORTRAN array to another
5. COCEN - converts binary to characters
6. CRIT - computes the critical crack length without growing the crack
7. CYCCNT - performs range-pair counting of the spectrum
8. GROW - supervisory crack growth routine
9. GETDAT - gets control card information
10. INPUT - reads the input data, consisting of the crack-growth-rate equation and load interaction model parameters, material and geometric constants, spectrum input, and output controls
11. LIBBD - provides titles for crack library; i.e., stress-intensity-factor solutions
12. NEWLFN - changes file name in FIT for versatile file number input when spectra are stored.
13. NUMBER - converts a character to an integer
14. OUTPUT - prints the echo of the input data and control printout options

15. PLOT - plots the grid, labeling, and data points for subroutine
PTPARM
16. PTPARM - directs plotting of crack growth analysis results

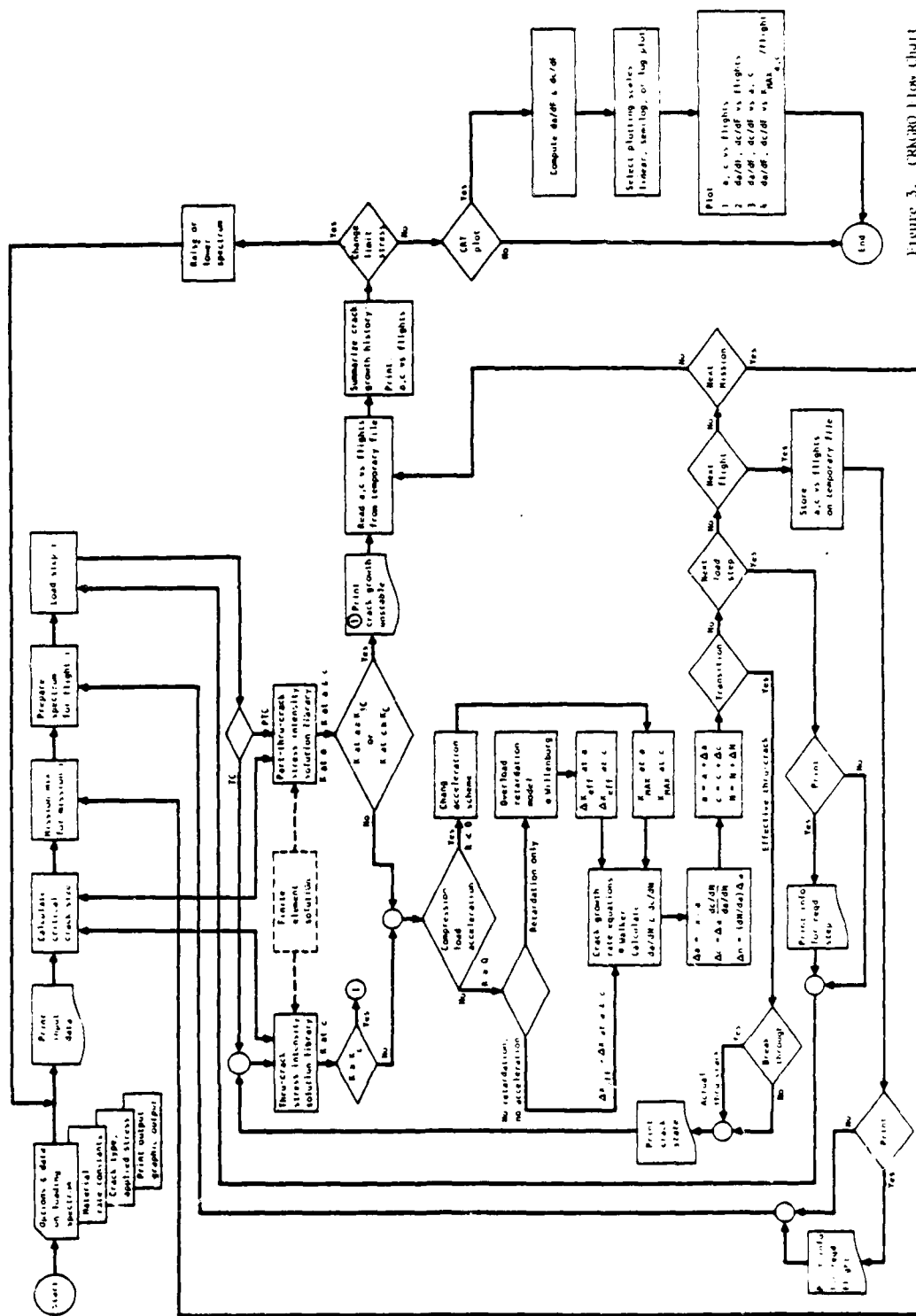


Figure 3. CRK(R) Flow Chart

Section IV

CRKGRO INPUT DATA DECK

The input data deck for CRKGRO is described in this section. A brief description of each type of input data card is presented in the following list, the overall deck setup is shown in figure 4, and a detailed description of each card follows

<u>Card</u>	<u>Description</u>
1a	"TITLE" keyword
1b	Title cards
1c	"END" keyword
2a	"MATERIAL" keyword
2b	Material description card
2c	Crack-growth-rate equation constants
2d	Material properties
3a	"THRESHOLD" keyword
3b	Delta K-threshold and variable delta K-threshold constant
4a	"LIMITS" keyword
4b	Initial and final crack sizes and stress ratio cutoff values
5a	"ANALYSIS" keyword
5b	Load interaction specifications
5c	Crack code and crack geometry
5d	Limit stresses
6a	"SPECTRUM" keyword
6b	Spectrum title card
6c	Spectrum scale factor, range-pair counting option, and file number
6d	Keyword for spectrum type, "MAX-MIN," "R-DELTA," "MEAN-ALT," and flight mission segment title
6e	Stress spectrum and occurrences
6f	"END" keyword
6g	"END SPECTRUM" keyword
6h	Mission mix
6i	Number of flights per block

<u>Card</u>	<u>Description</u>
7a	"OUTPUT" keyword
7b	Print and plot options
7c	Plotter type
7d	Plot types and scaling
8	"END DATA" keyword

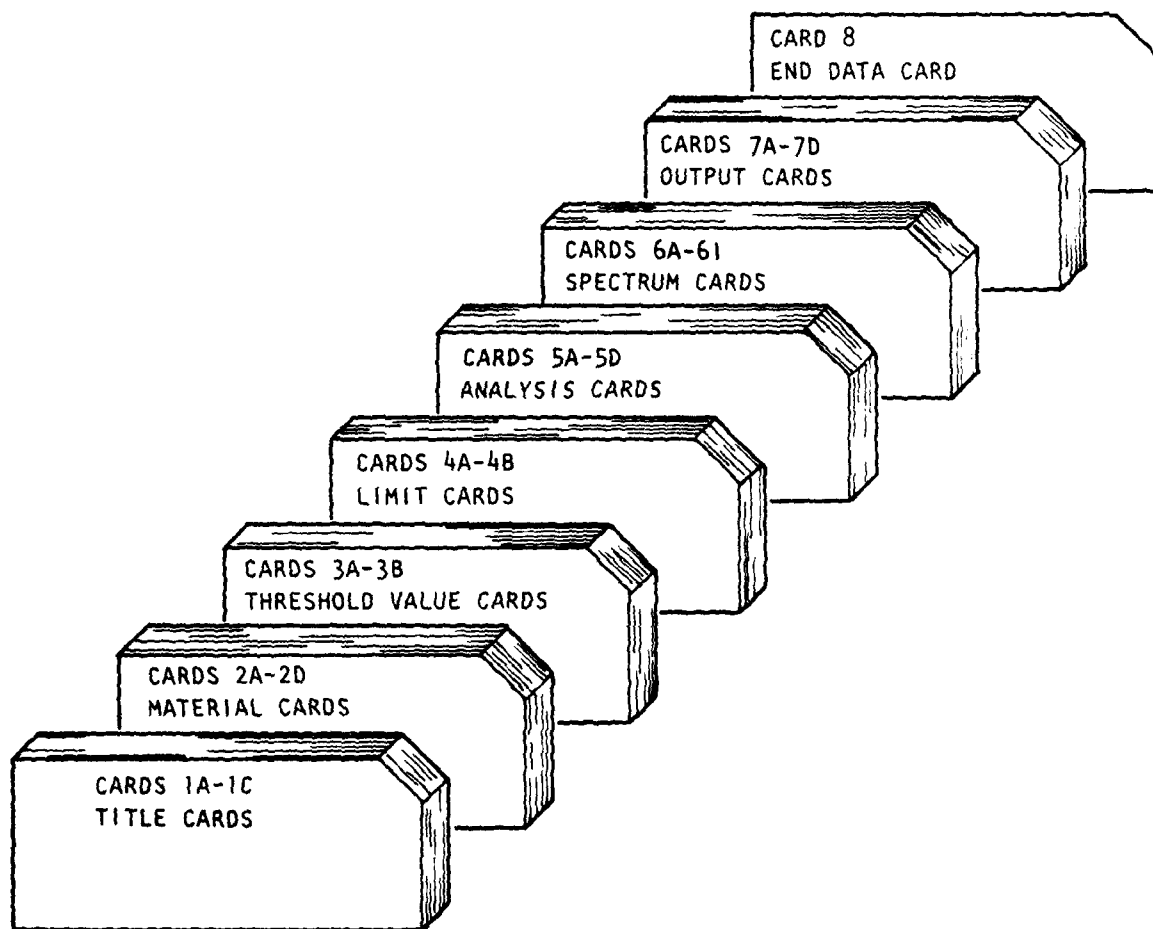


Figure 4. CRKGRO Input Deck Setup

INPUT DATA CARD 1a

Description: Title card keyword

Format and Example:

Column	1	5	6	80
--------	---	---	---	----

OPTION	
TITLE	

Field

Contents

OPTION "TITLE" keyword, beginning in column 1

Remarks: This card initiates the input of the title cards.

INPUT DATA CARDS NO. 1b

Description: Title cards

Format and Example:

<u>Column</u>	1	72	80
	TITLE(1) through TITLE (18)		
	BENCHMARK 443 FOR A DOUBLE CORNER CRACK		

Field

Contents

TITLE (I),
I = 1, 18

Any alphanumeric information which the user desires to
input for problem identification

Remarks:

There is no limit to the number of title cards input.
All title cards are printed on the first page of output,
but only the first title card is printed on succeeding
pages and all plots.

INPUT DATA CARD 1c

Description: Termination of title card input

Format and Example:

<u>Column</u>	1	3	4	80								
	<table><tr><td>OPTION</td><td colspan="3"></td></tr><tr><td>END</td><td colspan="3"></td></tr></table>				OPTION				END			
OPTION												
END												

<u>Field</u>	<u>Contents</u>
OPTION	'END' keyword, beginning in column 1 for terminating title card input

INPUT DATA CARD NO. 2a

Description: Material card keyword

Format and Example:

Column 1 8 9 80

OPTION	
MATERIAL	

Field

Contents

OPTION "MATERIAL" keyword, beginning in column 1.

Remarks: This card initiates the input of the material description,
crack-growth-rate constants, and static material properties.

Description: Material description

Column	1	60	70	80
--------	---	----	----	----

MATID(1) through MATID(7)	BISLP	
2219-T851 ALUMINUM		

Field

Contents

```

MATID(I),
      I = 1, 6

```

Any Alphanumeric information which the user desires to input for material identification. 60 columns can be used for input

BISLP

Option to use single or bi-slope crack growth rate curves

Blank - analyze with single-slope rate curve
"BISLOPE" - analyze with bi-slope rate curve

INPUT DATA CARD NO. 2c

Description: Crack-growth-rate constants

Format and Example:

Column	1	10	20	30	40	50
	CSUBC	EXPNC	CSUBA	EXPNA	EXPM	
	5.066 E-10	3.83	5.066 E-10	3.83	0.60	

	60	80
	EXPQ	
	1.0	

<u>Field</u>	<u>Contents</u>
CSUBC	Crack-growth-rate equation coefficient C_c used in dc/dN equation
EXPNC	Crack-growth-rate equation exponent n_c used in dc/dN equation
CSUBA	Crack-growth-rate equation coefficient C_a used in da/dN equation
EXPNA	Crack-growth-rate equation exponent n_a used in da/dN equation
EXPM	Positive stress ratio collapsing factor m used in the modified Walker equation
EXPQ	Negative stress ratio acceleration index q used in the Chang equation

Remarks:

1. CSUBC and CSUBA must be in ksi units.
2. If the "BISLOPE" option is used (see card 2b) an extra input card is required for the lower part of the rate curve. This card is similar to card 2c, where CSUBCL, EXPNCL, CSUBAL, EXPNAL, EXPML, EXPQL is as defined above but for the lower part i.e. region I of the da/dN

versus ΔK rate curve, with the additional input values of TRANSL and ATLEV in columns 61-65 and 66-72, respectively.

TRANSL - ΔK at transition from upper to lower curve
(e.g.: 3.7)

ATLEV - the level of da/dN at transition from upper to lower curve (e.g.: $1.0 \cdot 10^{-7}$)

INPUT DATA CARD 2d

Description: Material properties

Format and Example:

Column	1	10	20	30	80
	CKC	AKIC	SIGMAY		
	65.	45.	48.		

Field

Contents

CKC	Plane stress fracture toughness K_{IC} (ksi $\sqrt{\text{in.}}$) used for the through-crack instability criterion
AKIC	Plane strain fracture toughness K_{IC} (ksi $\sqrt{\text{in.}}$) used for the part-through-crack instability criterion
SIGMAY	Material yield strength, σ_{ty} (ksi)

INPUT DATA CARD 3a

Description: Threshold keyword card

Format and Example:

Column	1	9	80				
	<table><tr><td>OPTION</td><td></td></tr><tr><td>THRESHOLD</td><td></td></tr></table>			OPTION		THRESHOLD	
OPTION							
THRESHOLD							

Field

Contents

OPTION 'THRESHOLD' keyword, beginning in column 1

Remarks: This card initiates the input for the ΔK threshold option.

Description: Delta K-threshold and Constant

Column	1	10	20	80
--------	---	----	----	----

<u>Field</u>	<u>Contents</u>
DELKTH	The fixed threshold value of ΔK at $R = 0$, ΔK_{th_0} (Ksi $\sqrt{\text{in.}}$)
THA	The variable threshold constant

28

INPUT DATA CARD 4b

Description: Initial and final crack sizes and stress ratio cutoff values

Format and Example:

Column 1 10 20 30 40 50 60

CINIT	CF	AINIT	AF	RCUT	RCUTN	
0.06	0.90	0.06	0.5	0.75	-0.50	

Field

Contents

CINIT Initial crack length (in.)

CF Final crack length (in.)

AINIT Initial crack depth (in.)

AF Final crack depth (in.)

RCUT The cutoff value of the positive stress ratio "R+," above which the material is assumed to have no stress ratio layering effect on the crack growth.

RCUTN The cutoff value of the negative stress ratio "R-," below which the material is assumed to have no acceleration effect on the crack growth

Remarks:

1. If CF = 0, or blank, CF will be set equal to:
 - a. the half width - for surface and center-thru cracks
 - b. the width - for edge cracks
 - c. the (half width-radius) - for cracks at holes.

Analysis will terminate when either the critical crack size occurs or the crack length is equal to CF.
2. If AINIT = 0. or blank, and the crack type is a part through crack, the execution will terminate.
3. If AF = 0. or blank, AF will be set equal to the thickness. Analysis will terminate when either the critical crack size occurs or the crack depth is equal to AF.

4. RCUT must be in the range: $0. \leq RCUT < 1.$

5. RCUTN must be in the range: $-1.0 < RCUTN \leq 0.$

INPUT DATA CARD 5a

Description: Analysis keyword card

Format and Example:

Column	1	8	80				
	<table><tr><td>OPTION</td><td></td></tr><tr><td>ANALYSIS</td><td></td></tr></table>			OPTION		ANALYSIS	
OPTION							
ANALYSIS							

Field

Contents

OPTION "ANALYSIS" keyword, beginning in column 1

Remarks: This card initiates the input of load interaction data, crack code, crack geometry, and limit stresses.

INPUT DATA CARD 5b

Description: Load interaction specification

Format and Example:

Column 1 20 30 40

RET	RETTYP	RETDA	
LOAD INTERACTION	YES	3.0	

Field

Contents

RET "LOAD INTERACTION" keyword, beginning in column 1

RETTYP Load interaction application. If "NO" is input, no load interaction will be considered in the analysis, and the compressive minimum stresses will be set to zero. If RETTYP is blank or "YES," overload retardation and compression acceleration are considered. If "BOTH" is input, then both analyses will be performed.

RETDA Retardation shutoff ratio

Remarks: The value of RETTYP must begin in column 21.

INPUT DATA CARD 5c

Description: Crack code and crack geometry

Format and Example:

Column	1	4	8	11	20	30	40	50
	CODE	DIM	WIDTH	T	RADIUS	NBRK		
	1050	ONED	4.0	0.5	0.125	0		

<u>Field</u>	<u>Contents</u>
CODE	Crack code consisting of four integers, beginning in column 1
DIM	Blank - Two-dimensional analysis "ONED" - One-dimensional analysis, beginning in column 5
WIDTH	Width of structure, $W = 2b$ (in.) for non-edge cracks $W = b$ (in.) for edge cracks
T	Thickness of structure, t (in.)
RADIUS	Radius of open hole, r (in.)
NBRK	Control for transition from a part-through crack to a through crack For $NBRK = 0$, breakthrough occurs when $a/t = 1$. For $NBRK = 1$, breakthrough occurs at $a/t = 0.5 [1/0.86 (a/2c)]^{0.821}$
<u>Remarks:</u>	1. Refer to figure 2 for a description of crack codes available in the current version of CRKGRO.

INPUT DATA CARD 5d

Description: Limit stresses and analysis control parameters

Format and Example:

Column	1	10	20	30	
	NLIM	SIGLIM(1)	INSTAB		
	3	10.	BY MAXIMUM		

1	10	20	30	40	
SIGLIM(2)	SIGLIM(3)	- - - - -	SIGLIM(NLIM)		
.85	1.2				

Field

Contents

NLIM Number of limit stresses, integer, right-adjusted

SIGLIM(1) Limit stress in ksi

INSTAB Control for determining when instability is reached:
 (Starting in column 21.)

 "BY MAXIMUM" - by stress-intensity-factor value at
 maximum spectrum stress

 "Blank" - by stress-intensity-factor value at limit stress

SIGLIM(I), Ratio of the ith limit stress to the first limit stress
 I = 2,7

Remarks:

1. If NLIM is greater than 1, then a parametric study is performed with the change in limit stress. The spectrum stresses also change by the ratio of limit stress change.
2. Limit stress ratios, SIGLIM(2-7), are input in fields of 10 on the next data card. A maximum of six limit stress ratios may be input on this card.

INPUT DATA CARD 6a

Description: SPECTRUM card keyword

Format and Example:

Column	1	10	80
--------	---	----	----

OPTION	
SPECTRUM	

Field

Contents

OPTION "SPECTRUM" keyword, beginning in column 1

Remarks: This card initiates the input of the spectrum data.

INPUT DATA CARD 6b

Description: Spectrum title card

Format and Example:

Column	1	70	80
	STITLE(1) through (7)		
	FIGHTER SPECTRUM		

Field	Contents
STITLE(I), I = 1,7	Any alphanumeric information which the user desires to input for overall spectrum identification

Remarks: Only information in columns 1-70 is printed.

INPUT DATA CARD 6c

Description: Spectrum scale factor, range-pair counting option and file number for stored spectrum (if any)

Format and Example:

Column 1 10 15 20 80

FAC	NRP	NFILE	
1.0	1	12	

Field

Contents

FAC

Factor used to scale the spectrum

NRP

Control for range-pairing each spectrum segment:

0 - no range-pair counting operation

1 - range-pair counting option

NFILE

Unit number of file where spectrum is stored:

Blank - spectrum will be read in from cards

10-98 - spectrum will be read in from given file

Remarks:

1. All maximum and minimum stresses are scaled by the value of FAC.
2. The values of NRP and NFILE are integers, right-adjusted.

INPUT DATA CARD 6d

Description: Spectrum-type keyword and segment title

Format and Example:

Column 1 10 70 80

SPCTYP	SEGTTL(1) through SEGTTL(6)	
MAX-MIN	AIR-TO-GROUND SPECTRUM	

Field

Contents

SPCTYP Spectrum-type keyword defining the following data cards as one of the following:

 'MAX-MIN' - maximum and minimum stresses are input

 'R-DELTA' - stress ratio and delta stress are input

 'MEAN' - mean and alternating stresses are input

SEGTTL(I) Mission segment description
 I = 1, 6

Remarks:

1. The keyword for SPCTYP begins in column 1.
2. The mission segment description can be input in columns 11-70.
3. Cards 6d to 6f must be repeated for as many segments as there are in the spectrum to a maximum of 20 segments. There is no limit to the number of steps per segment, although a limit of 3,000 steps is established for the entire spectrum.
4. This card should always be a part of the input deck (not a part of a stored spectrum).

INPUT DATA CARD 6e

Description: Stress spectrum

Format and Example:

Column 1 5 15 25 35

	S1	S2	CYCLES	
	12.	-2.	1.	
	25.	10.	.01	
	6.5	2.1	25.	
	8.4	5.2	500.	

Field

Contents

S1 Depending on the spectrum type, S1 is one of the following:

1. Maximum stress
2. Delta stress
3. Mean stress

S2 Depending on the spectrum type, S2 is one of the following:

1. Minimum stress
2. Stress ratio
3. Alternating stress

CYCLES Number of occurrences for each type of loading

Remarks:

1. The spectrum is considered to be in ksi units.
2. A value for CYCLES < 1 will be applied every $(\text{CYCLES})^{-1}$ times. If CYCLES = 0.1, the loading will be applied every 10th time that the flight segment is repeated.
3. A maximum of 3,000 steps is established for the entire spectrum.
4. If the spectrum is in terms of % design limit stress, the scale factor (card 6c) will convert the spectrum into the correct stress level.

INPUT DATA CARD 6f

Description: End-of-flight segment keyword card

Format and Example:

Column	1	10	80
--------	---	----	----

ENDSEG	
END	

Field

Contents

ENDSEG	"END" keyword, beginning in column 1 for terminating flight segment spectrum input
--------	------------------------------------------------------------------------------------

Remarks:

1. The succeeding data card is either a flight-segment-type card 6d or card 6g.
2. If the spectrum is stored on a file, then the keyword "END" must also be stored on the file after each segment and/or at the end of the spectrum.

INPUT DATA CARD 6g

Description: End-of-spectrum keyword card

Format and Example:

Column 1 12 80

ENDSPC	
END SPECTRUM	

Field

Contents

ENDSPC "END SPECTRUM" keyword, beginning in column 1 for
terminating spectrum input

Remarks: This card should always be a part of the input deck (not
part of a stored spectrum).

INPUT DATA CARD 6h

Description: Mission mix

Format and Example:

Column 1 80

MISSION = NBLKS * Σ (FACTORi*SEGMENTi)
MISSION = 2500 (2S1 + 3S2 + 1S1 + 2S3)

<u>Field</u>	<u>Contents</u>
MISSION	'MISSION =' keyword, starting in column 1
NBLKS	Number of times the complete mission string is repeated
FACTORi	Number of times the individual flight segment is repeated
SEGMENTi	Mission segment number preceded by the letter "S" for segment
<u>Remarks:</u>	<ol style="list-style-type: none"> The example illustrates an equation for mission mix. The characters 'MISSION =' are required to initiate the mission mix. The parentheses are required, and the terms between them describe a complete mission string. All characters are free format. The maximum number of individual mission segments is 20 (S1.....S20), and the maximum number of mission segments-mix is 100 (1S1+.....). No limit is established for NBLKS. Other examples: MISSION = 10000 MISSION = 500 (1S1 + 1S2 + 1S3 + 1S4 + 1S5 + 1S6 + 1S5 + 1S4 + 1S3 + 1S2 + 1S1 + 1S2 + 1S3 + 1S4 + 1S5 + 1S6) The last entry must be a "+" sign for continuation of a mission-mix. The end of the mix is a closing parenthesis.

INPUT DATA CARD 6i

Description: Flights-per-block definition

Format and Example:

Column: 1 5 80

NFPB	
25	

Field

Contents

NFPB Number of flights per block, integer, right-adjusted

Remarks: 1. This value is used for plotting only.

INPUT DATA CARD 7a

Description: Output keyword card

Format and Example:

Column 1 6 80

OPTION	
OUTPUT	

Field

Contents

OPTION "OUTPUT" keyword, beginning in column 1

Remarks: This card initiates the input of printer and plotter controls.

INPUT DATA CARD 7b

Description: Print and plot options

Format and Example:

Column	1	5	10	15	20	25	30	35	40	45
	IPRSPC	NB	NCRT			NJUMP	IPR72	KPRT	INPRT	LNBLK
	1	10	1			1	0	1	0	-25

Field

Contents

- IPRSPC Control for printing the spectrum to be used
- 1 - print
 - 0 - suppress print
- NB Control for printing the crack growth history in increments of NB number of blocks. The default value is 175.
- NCRT Control for plotting and reading plotting data:
- 1 - read plotting parameters on succeeding cards
 - 0 - no plotting
- NJUMP Control for bypassing slow-growth steps:
- 0 - bypass steps with a growth rate less than 10^{-8} and $\Delta K < .2 \Delta K_{\max_x}$
 - 1 - retain slow-growth steps in analysis
- IPR72 Control for limiting the line size:
- 1 - printed output will have a 72-column width
 - 0 - printed output will have a 108-column width
- KPRT Control for printing stress intensity equations used
- 1 - print K equations
 - 0 - do not print

INPUT DATA CARD 7b (Concluded)

<u>Field</u>	<u>Contents</u>
INPRT	Control for printing growth history of first block 1 - do not print 0 - print first block's growth
LNBLK	Control for printing intermediate growth history -i - growth of the first ith steps of each 'NB'th block will be printed +i - growth of the last ith steps of each 'NB'th block will be printed o - all steps of 'NB'th block will be printed
<u>Remarks:</u>	If the spectrum is segmented and the first segment's number of steps <LNBLK, printing will stop at the 1st segment-end for "-i" or start at the last segment-start for "+i". First block's print will also follow LNBLK's option.

INPUT DATA CARD 7c

Description: Plotter-type specification

Format and Example:

Column 1 5 10 80

NPLTYP	IBAUD	
1	0	

Field

Contents

NPLTYP Plotter type for DISSPLA processing:

- 1 - SC4020
- 2 - Tektronix
- 3 - Unipost or Calcomp

IBAUD Tektronix terminal line speed in characters per second
(used only when NPLTYP = 2)

- Remarks:
- 1. All values are integers, right-adjusted.
 - 2. Card 7c is input only if "NCRT" on card 7b is 1.

INPUT DATA CARD 7d

Description: Plot types and scaling parameters

Format and Example:

Column 1 5 10 15 20 25 30 50 55 60

OPT(1)	OPT(2)	OPT(3)	OPT(4)	SCALE (1,1)	SCALE (2,1)	---	SCALE (1,4)	SCALE (2,4)	
1	1	1	1	0	0		0	1	

Field

Contents

OPT(1-4) Array specifying parameters to be plotted:

- 1 - plot
- 0 - no plot

OPT(1) = crack size versus life in flights OPT(2) = crack growth rate versus life in flights OPT(3) = crack growth rate versus crack size OPT(4) = crack growth rate versus maximum K_{max} per flight	}	Y vs X
-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------	---	--------

SCALE(2,4) Array specifying linear, semilog, or log-log grid scaling:

1. SCALE(1,*) = 0 - X-axis is linear
 1 - X-axis is log
2. SCALE(2,*) = 0 - Y-axis is linear
 1 - Y-axis is log

Remarks:

1. All values are integers, right-adjusted.
2. For part-through cracks, separate plots are produced for both crack length and depth.
3. Because one block represents the whole segment series or mission-mix expression between the parentheses on card 6h, the number of flights on card 6i must reflect both the multiple applications and segment repetitions.
4. Card 7d is input only if "NCRT" on card 7b is 1.

INPUT DATA CARD 8

Description: End-of-data keyword card

Format and Example:

Column 1 8 80

OPTION	
END DATA	

Field

Contents

OPTION "END DATA" keyword, beginning in column 1

Remarks: This card terminates the reading of input data. If no
input data errors were encountered, execution begins;
otherwise, the program is terminated.

Section V

EXAMPLE CASES

This section presents two example cases which are designed to illustrate the capability of the CRKGRO program and exercises most of the program options. The first example is the crack growth prediction for a surface crack contained in a finite width plate as shown in figure 1, subjected to spectrum loadings. For the purpose of illustration, the spectrum selected for the analysis was a small block of random flight spectrum which consists of 57 cycles. Each cycle has different stress levels. The analysis was done by the two-dimension crack growth analysis option. Crack growth rate constants used in the analysis were the bi-slope constants. The following data were used in the analysis.

Material:

2219-T851 Aluminum Plate

Region II (upper slope) crack growth rate constants

$$C = 5.066 \times 10^{-10} \text{ (in ksi unit)}$$
$$n = 3.83$$

Bi-slope transition point:

$$da/dN = 6 \times 10^{-7} \text{ in/cyc} \quad \Delta K = 5 \text{ ksi} \sqrt{\text{in}}$$

Region I (lower slope) crack growth rate constants

$$C = 2.126 \times 10^{-13} \text{ (in ksi unit)}$$
$$n = 9.23$$

Crack growth rate parameters and fracture properties:

$$m = 0.6$$

$$\alpha = 1.0$$

$$K_{th_0} = 2.5 \text{ ksi} \sqrt{\text{in}}$$

$$A = 1.0$$

$$R_{cut}^+ = +0.75$$

$$R_{cut}^- = -0.99$$

$$R_{so} = 3.0$$

$$\sigma_{ty} = 48 \text{ ksi}$$

$$K_{Ic} = 45 \text{ ksi} \sqrt{\text{in}}$$

$$K_c = 65 \text{ ksi} \sqrt{\text{in}}$$

Plate dimensions:

$$2b = 6.0 \text{ in.}$$

$$t = 0.25 \text{ in.}$$

Initial crack sizes:

$$a_i = 0.10 \text{ in.}$$

$$a_i/2c_i = 0.5$$

All the input echoes and the print-outs of the output including the graphics are shown in the next few pages. Brief descriptions are provided for each page of the output printouts.


```

24.0 4
35.0 14.4
51.0 8.0
23.5 8.1
59.7 2.9
67.1 2.7
57.2 1.0
35.4 1.2
27.4 1.5
19.7 1.7
37.1 1.3
51.0 1.1
26.6 1.2
41.6 1.0
26.4 1.1
19.5 1.4
31.4 1.3
22.5 1.5
12.0 1.6
44.2 1.0

```

END SPECTRUM
MISSION=53333
OUTPUT 1 2000
END DATA

1 0 -20

Above are the printouts of the input card image listing. Each line contains the data punched in one card. The first three lines are the title cards. The next five lines are the material cards, followed by threshold value cards (lines 9 and 10), limit cards (lines 11 and 12); analysis cards (lines 13 through 16); spectrum cards (lines 17 through 81); output cards (lines 82 and 83) and end data card (line 84).

Remarks:

DETAILED FATIGUE CRACK GROWTH ANALYSIS PROGRAM C R K E R O

SAMPLE CASE FOR SURFACE FLAW

CRACK CODE 1010 --- SURFACE CRACK, CENTERED

LOAD INTERACTION : WILLFIBJPG-CHAMP

DAMAGE ACCUMULATION : VROMAN (LINEAR APPRX.)

CRACK GROWTH RATE EQ. MODIFIED WALKER

ANALYSIS IS PERFORMED WITH A SPECTRUM THAT HAS BEEN RANGED PAIRED.

INSTABILITY WILL BE BASED ON MAXIMUM STRESS

MATERIAL : 2219-T451 ALUMINUM

RISLOPE

FRACTURE TOUGHNESS

REGION I :
GROWTH RATE EQ. CONST. C
GROWTH RATE EQ. EXP. N
GROWTH RATE EQ. EXP. M
GROWTH RATE EQ. EXP. Q

DEPTH DIRECTION
45.000 65.000

5.0669E-1 5.0669E-10
3.83 3.8300
0.69 3.8300
1.00 3.8300

TRANSITION TO LOWER CURVE
GROWTH RATE EQ. CONST. C
GROWTH RATE EQ. EXP. N
GROWTH RATE EQ. EXP. M
GROWTH RATE EQ. EXP. Q

AT 5.000
2.1260E-13
9.2300
1.60
1.0000

YIELD STRENGTH 44.00

DELTA KTH = (1.0 - 1.00 * RMS(R)) * 2.500

+K CUT-OFF = .75

-R CUT-OFF = -.95

RETARDATION SHUT-OFF RATIO FOR CRACK ARREST = 2.3000

HALF PLATE WIDTH (P) = 5.000
PLATE THICKNESS (T) = .250

INITIAL HALF CRACK LENGTH (C) = .1000
INITIAL CRACK DEPTH (A) = .1000
A/C RATIO = 1.000

MISSION SUMMARY

MAXIMUM NUMBER OF LOAD BLOCKS = 500
 THE LOADING SPECTRUM HAS 1 MISSION(S)
 DESIGN LIMIT STRESS = 30,000 (KSI)

MISSION	NO. OF OCCURRENCES	NO. OF STEPS	CYCLES/MISSION--SEGMENT BEFORE RPC
1	1	57	57.0
TOTALS	1	57	57.0 CYCLES

VARIABLE SPECTRUM SAMPLE CASE

SPECTRUM HAS BEEN RANGE-PAIR COUNTED

SPECTRUM FOR SEGMENT 1

STFP NO	MAX. STRESS	MIN. STRESS	CYCLES
1	15.250	1.200	1.000
2	12.570	8.880	1.000
3	16.030	2.340	1.000
4	14.470	1.690	1.000
5	11.330	2.520	1.000
6	11.530	5.340	1.000
7	14.350	1.260	1.000
8	8.370	4.140	1.000
9	12.270	3.420	1.000
10	22.230	3.000	1.000
11	10.330	6.000	1.000
12	6.350	2.340	1.000
13	11.140	5.570	1.000
14	17.430	3.450	1.000
15	21.050	3.390	1.000
16	13.050	3.270	1.000
17	16.180	2.550	1.000
18	15.470	1.840	1.000
19	16.770	2.180	1.000
20	14.590	9.510	1.000
21	15.190	2.070	1.000
22	13.330	7.590	1.000
23	13.290	9.180	1.000
24	13.290	9.920	1.000
25	19.830	1.470	1.000
26	8.8	2.430	1.000
27	8.8	3.320	1.000
28	8.8	3.320	1.000
29	8.8	3.320	1.000
30	8.8	3.320	1.000

1	5.400	1.000
2	2.400	1.000
3	4.720	1.000
4	.870	1.000
5	2.430	1.000
6	2.610	1.000
7	2.300	1.000
8	3.690	1.000
9	2.000	1.000
10	2.660	1.000
11	3.550	1.000
12	3.540	1.000
13	1.550	1.000
14	2.670	1.000
15	2.710	1.000
16	3.750	1.000
17	1.800	1.000
18	1.090	1.000
19	1.500	1.000
20	1.530	1.000
21	1.710	1.000
22	0.800	1.000
23	3.210	1.000
24	1.290	1.000
25	.480	1.000
26	.330	1.000
27	14.460	1.000

***** END OF INPUT *****

Remarks: Above are the input echoes arranged in a format such that they can be included directly in the crack growth analysis report.

CRACK GROWTH RATE EQUATION

$$da/dN = C \cdot \Delta K / ((1-R) \cdot ((1-H))) \cdot N$$

STRESS INTENSITY FACTOR SOLUTIONS

FOR A SHALLOW SURFACE CRACK WHERE $a/C \leq 1$

$$Y(A) = ((1.13 - 0.75A/C) + (0.69 / ((1.2 + A/C) - 0.54)(A/T))^{.2} + (0.5 - 1 / ((0.65 + A/C) - 14(1 - A/C)^{.24})(A/T)^{.4}) \cdot \text{SQRT}(\text{SEC}(\text{PI} \cdot C / 2B) \cdot \text{SQRT}(A/T)) \cdot \text{SIGMA} \cdot \text{SQRT}(\text{PI} \cdot A / Q)$$

$$K(C) = ((1.13 - 0.75A/C) + (0.69 / ((1.2 + A/C) - 0.54)(A/T))^{.2} + (0.5 - 1 / ((0.65 + A/C) + 14(1 - A/C)^{.24})(A/T)^{.4}) \cdot \text{SQRT}(\text{SEC}(\text{PI} \cdot C / 2B) \cdot \text{SQRT}(A/T)) \cdot \text{SIGMA} \cdot \text{SQRT}(\text{PI} \cdot A / Q)$$

$$\cdot (1.07 + 24(A/T)^{.2}) \cdot (.9498(A/C)^{.2} + .0302)^{.25}$$

$$\cdot \text{SQRT}(A/C) \cdot \text{SIGMA} \cdot \text{SQRT}(\text{PI} \cdot C / Q)$$

$$\text{WHERE } Q = (1 + 1.464(A/C)^{.65})$$

FOR A DEEP SURFACE CRACK WHERE $a/C > 1$

$$K(A) = ((\text{SQRT}(C/A) \cdot (1 + 1.04C/A) + (.2(C/A)^{.4} (A/T)^{.2} - 0.11(C/A)^{.4} (A/T)^{.4}) \cdot \text{SQRT}(\text{SEC}(\text{PI} \cdot C / 2B) \cdot \text{SQRT}(A/T))) \cdot \text{SIGMA} \cdot \text{SQRT}(\text{PI} \cdot A / Q)$$

$$K(C) = ((\text{SQRT}(C/A) \cdot (1 + 1.04C/A) + (.2(C/A)^{.4} (A/T)^{.2} - 0.11(C/A)^{.4} (A/T)^{.4}) \cdot \text{SQRT}(\text{SEC}(\text{PI} \cdot C / 2B) \cdot \text{SQRT}(A/T))) \cdot \text{SIGMA} \cdot \text{SQRT}(A/C))$$

$$\cdot (1.07 + 24(C/A)(A/T)^{.2}) \cdot (.9698 + .0302(C/A)^{.2})^{.25}$$

$$\cdot \text{SIGMA} \cdot \text{SQRT}(\text{PI} \cdot C / Q)$$

$$\text{WHERE } Q = (1 + 1.464(C/A)^{.65})$$

FOR A CENTER THROUGH CRACK

$$K = \text{SQRT}(\text{SEC}(\text{PI} \cdot C / 2B)) \cdot \text{SIGMA} \cdot \text{SQRT}(\text{PI} \cdot C)$$

Remarks:

Above is the printout of the crack growth rate equation and stress intensity factor equations used in the crack growth analysis for crack codes 1010 and 2010.

SAMPLE CASE FOR SURFACE FLAW

ESTIMATION OF THE CRITICAL CRACK LENGTH BASED ON KLIMIT AND CONSTANT ASPECT RATIO			
ITERATION	CRACK SIZE	STRESS INTENSITY (LIMIT)	STRESS INTENSITY CORRECTION FACTOR
1	.1000	8.961	.9272
2	.2500	23.663	1.3971
1	.2500	26.701	1.0043
2	2.9850	1136.646	11.2840
3	1.6175	83.999	1.2284
4	.9334	54.685	1.0643
5	1.2756	67.776	1.1286
6	1.1047	61.976	1.0928
7	1.1902	64.374	1.1057
8	1.2329	66.061	1.1189
9	1.2115	65.214	1.1142

APPROXIMATE CRITICAL CRACK (A_{CR C}) = 1.212
WHEN K-LIMIT IS WITHIN A 5.5% TOLERANCE OF K CRITICAL

Remarks: This is the printout of the critical crack size calculation based on the design limit stress. The calculation is performed through subroutine CRIT by an iteration procedure.

SAMPLE CASE FOR SURFACE FLAW

THE CRACK AT THE BEGINNING OF FLICK

A = .100000
C = .100000

STRP	CYCLES	A C	A/2C A/1	DA/DM DC/DM	DELTA K DELTA CK	KMAX-A KMAX-C	SIGMAX-A SIGMAX-C (EFF)	R-A R-C (EFF)	SIGMAX	R
1	1.	1.000	5.000	3.414E-07	5.30	5.76	15.030	.68	15.030	.78
2	1.	1.000	4.000	3.711E-07	5.87	6.38	15.030	.68	12.570	.71
3	1.	1.000	4.000	3.711E-07	1.157	4.91	11.564	.69	6.030	.79
4	1.	1.000	5.000	4.41E-07	1.157	2.56	14.518	.12	14.670	.13
5	1.	1.000	5.000	3.56E-06	2.330	6.19	14.505	.13	11.130	.23
6	1.	1.000	4.000	3.88E-06	3.666	3.13	9.717	.17	11.340	.47
7	1.	1.000	4.000	4.47E-06	2.733	3.24	9.976	.25	8.580	.62
8	1.	1.000	5.000	3.34E-11	1.238	2.98	7.023	.54	14.850	.18
9	1.	1.000	5.000	4.41E-07	1.277	5.67	7.775	.08	8.070	.51
10	1.	1.000	5.000	3.33E-11	1.517	2.81	6.622	.44	12.670	.27
11	1.	1.000	4.000	3.32E-06	3.691	4.62	19.055	.12	22.230	.13
12	1.	1.000	5.000	4.46E-06	9.663	8.54	22.230	.13	10.350	.59
13	1.	1.000	5.000	5.15E-11	1.633	2.84	27.422	.14	6.300	.37
14	1.	1.000	5.000	4.47E-11	1.812	5.41	6.300	.37	11.850	.65
15	1.	1.000	5.000	1.18E-08	1.680	3.57	5.575	.27	7.140	.50
16	1.	1.000	5.000	3.33E-11	3.777	3.89	8.435	.35	21.450	.72
		1.000	5.000	3.15E-11	1.502	2.22	5.312	.43		
		1.000	5.000	5.38E-06	8.092	8.91	21.450	.02		

SAMPLE CASE FOR SURFACE FLAW

THE CRACK AT THE BEGINNING OF BLOCK 1 A = .100000
C = .100000

STEP	CYCLES	A C	A/2C A/T	DA/DN DC/DN	DELIAK DELICK	KMAX-A KMAX-C	SIGMAX-A SIGMAX-C (FFF)	R-A R-C (FFF)	SIGMAX	P
17	1.	.1000 .1000 .1000 .1000 .1000 .1000 .1000	.5000 .4020 .5000 .5000 .5000 .5000 .5000	4.079E-08 6.574E-08 1.373E-09 1.373E-09 3.543E-07 5.276E-07 2.541E-07	3.71 4.12 2.55 3.83 5.49 6.09 5.84	3.78 4.05 2.64 3.65 5.65 6.20 4.88	9.85E 9.541 4.895 6.322 14.743 14.607 12.751	.02 -.02 -.03 -.03 -.03 -.02 -.21	13.08E 9.930 16.890 15.420	.26 .33 .15 .61

THE CRACK AT THE END OF BLOCK 1 A = .100378
C = .100313

Remarks:

Above are the printouts of the detail data related to the performance of the cycle-by-cycle crack growth analysis. For each step, the printouts show the data in the following order: step number, number of cycles in this step, calculated crack depth (a) and half-crack length (c), calculated da/dn and dc/dn, calculated ΔK_a and ΔK_c , calculated $K_{max,a}$ and $K_{max,c}$, calculated effective σ_{max} , calculated effective stress ratio, input remote maximum cyclic stress, and input stress ratio.

Detailed data for the first 20 steps of the input spectrum are shown in the printout as requested.

The last line in the printout indicated that after the application of the first block (57steps) of the spectrum, the crack is a = 0.100008 in., c = 0.100013 in.

SAMPLE CASE FOR SURFACE FLAW

THE CRACK AT THE BEGINNING OF BLOCK 200.

A = .122259
C = .131754

STEP	CYCLES	A	A/2C	DA/DN DC/DN	DELTA DELTC	KMAX-A KMAX-C	SIGMAX-A SIGMAX-C (EFF)	R-A R-C (EFF)	SIGMAX	R
1	1.	.1223	.4640	3.517E-07	6.24	5.38	11.939	.16	15.030	.05
4	1.	.1314	.4915	4.71E-07	6.79	5.78	11.777	.17	14.670	.13
5	1.	.1223	.4640	3.470E-07	5.27	5.16	11.452	.12		
6	1.	.1314	.4915	5.48E-08	6.88	5.53	11.277	.13	11.130	.23
8	1.	.1223	.4640	6.52E-08	4.22	3.35	6.835	.26	11.340	.43
10	1.	.1314	.4915	7.55E-08	2.90	3.33	7.387	.69	14.850	.08
11	1.	.1223	.4640	8.58E-07	6.13	3.47	11.696	.16	12.870	.27
14	1.	.1314	.4915	1.12E-06	4.26	4.12	8.894	.03	22.230	.13
16	1.	.1223	.4640	1.77E-06	11.38	10.03	22.230	.13	11.850	.05
17	1.	.1314	.4915	2.38E-07	5.76	3.72	9.245	.36	21.450	.12
18	1.	.1223	.4640	3.74E-06	9.47	9.67	21.450	.02	13.080	.26
19	1.	.1314	.4915	4.35E-07	4.37	4.23	9.152	.03	9.930	.33
20	1.	.1223	.4640	5.37E-09	3.27	2.76	5.618	.19	16.890	.15
21	1.	.1314	.4915	6.42E-07	7.84	7.69	14.444	.11	15.420	.01
22	1.	.1223	.4640	7.53E-07	6.87	5.62	12.458	.22		
23	1.	.1314	.4915	8.14E-07	7.48	6.04	12.318	.24		

THE CRACK AT THE END OF BLOCK 200

A = .122275
C = .131775

Remarks:

This is the printout which provided the detail data related to the cycle-by-cycle crack growth analysis. Again, only the first 20 steps of the spectrum were printed out.

SAMPLE CASE FOR SURFACE FLAW

THE CRACK AT THE BEGINNING OF BLOCK 4000 A = .171747
C = .200496

STEP	CYCLES	A C	A/2C A/1	DA/DN D/DN	DELTA DELTA K	KMAX-A KMAX-C	SIGMAX-A SIGMAX-C (EFF)	R-A R-C (EFF)	SIGMAX	R
1	1.	.1717	.4284	8.927E-07	8.10	6.76	11.541	.20	15.730	.38
4	1.	.2004	.4904	1.239E-06	6.90	7.33	11.388	.21	14.670	.13
5	1.	.1717	.4284	9.279E-07	7.48	6.45	11.021	.16		
6	1.	.2004	.4904	1.239E-07	8.23	6.99	10.856	.17	11.137	.23
8	1.	.1717	.4284	1.239E-08	5.04	3.68	6.279	.44		
10	1.	.2004	.4904	1.239E-08	5.54	3.85	5.527	.42	11.340	.43
11	1.	.1717	.4284	8.111E-08	3.76	3.83	6.574	.03	14.850	.08
14	1.	.2004	.4904	1.239E-06	7.96	6.61	11.283	.22	12.870	.27
16	1.	.1718	.4284	1.239E-05	6.75	7.16	11.122	.11	22.230	.13
17	1.	.2005	.4905	3.239E-07	5.53	4.58	8.507	.14	11.850	.05
18	1.	.1718	.4284	1.239E-07	6.98	5.33	6.282	.13	21.450	.02
19	1.	.2005	.4905	1.239E-05	14.78	13.02	22.230	.13	13.080	.26
20	1.	.1718	.4284	3.239E-07	16.24	14.31	22.230	.13	9.930	.37
		.2005	.4905	5.211E-06	7.22	4.78	7.292	.47	16.890	.15
		.1718	.4284	1.239E-07	12.52	12.56	21.450	.22	15.420	.11
		.2005	.4905	1.239E-07	15.68	13.81	21.450	.22		
		.1718	.4284	3.239E-07	5.24	5.51	8.555	.13		
		.2005	.4905	1.239E-08	3.97	2.86	4.558	.16		
		.1718	.4284	2.239E-08	4.29	2.52	4.538	.47		
		.2005	.4905	1.239E-06	8.40	8.37	14.287	.00		
		.1718	.4284	1.239E-06	8.23	9.14	14.185	.01		
		.2005	.4905	1.239E-06	8.93	7.08	12.082	.26		
		.1718	.4284	1.239E-06	9.81	7.79	11.957	.27		

THE CRACK AT THE END OF BLOCK 4000 A = .171747
C = .200496

BREAKTHROUGH HAS OCCURRED, A = .25061 C = .32334
AT 1.0 CYCLES OF STEP 15 IN BLOCK 5097

TRANSITION INTO CODE NR. 2613

Remarks: This printout provided the information on when the surface crack became the through-the-thickness crack. The total cycles applied were 5096 x 57 + 16 x 1 = 290,488 cycles.

SAMPLE CASE FOR SURFACE FLAW
 THE CRACK AT THE BEGINNING OF BLOCK 5615 C = .681804
 STEP CYCLES C BC/DN BELICK KMAX-G SIEMAX R SIEMAX R
 (EFF) (EFF)

 AT FRACTIONAL (.7, .8, OR .9) KSURC OF 45.500
 KLINITE 45.506
 IN BLOCK 5605 C 1-TH MIN 1-TH TIME STEP 16 CYCLE 9.0

Remarks:

This printout indicated that if the real fracture toughness
 of the material is $K_C = 45.5 \text{ ksi } \sqrt{\text{in}}$ (70% of input value),
 the crack will become unstable after the application of
 $5604 \times 57 + 15 = 319,443$ cycles of loading.

SAMPLE CASE FOR SURFACE FLAW
 THE CRACK AT THE BEGINNING OF BLOCK 5693 C = .854758
 STEP CYCLES -C DC/DN DELICK-KMAX-G-SIGMAX-R SIGMAX-R
 (EFF) (EFF)

 AT FRACTIONAL (.758) CR .9) KSUBC OF 2.000
 KLIMIT=52.078 C= .854758
 IN BLOCK 5693 { 1-TF-MIX 1-TF-TIME) STEP 29 CYCLE 9.8

Remarks:

This printout indicated that if the real fracture toughness of the material is $K_c \approx 52 \text{ ksi } \sqrt{\text{in}}$ (80% of the input value), the crack will become unstable after the application of $5692 \times 57 + 38 = 324,482$ cycles of loading.

SAMPLE CASE FOR SURFACE FLAW

THE CRACK AT THE BEGINNING OF BLOCK 5748 C = 1.020344

STEP CYCLES C BC/DN DELTCK KMAX-C SIGMAX R SIGMAX R (EFF) (EFF)

 AT FRACTIONAL 0.700 OR 0.9) KSUBC OF 58.500
 KLIMIT= 58.505 C= 1.031465
 IN BLOCK 5748 --(1-TH MIX 1-TH FINE) STEP 18 CYCLE 0.9

Remarks:

This printout indicated that if the real material fracture toughness is $K_c = 58.5 \text{ ksi } \sqrt{\text{in}}$ (90% of the input value), the crack will become unstable after the application of $5747 \times 57 + 17 = 327,596$ cycles of loading.

SAMPLE CASE FOR SURFACE FLAW

THE CRACK AT THE BEGINNING OF BLOCK 578? C = 1.1999E5

STFP CYCLES C DC/DN DELTEK KMAX C SIGMAX R SIGMAX R (EFF) (EFF)

 KLIMIT= 65.000 IS GREATER THAN KSOURCE 65.000
 VALUES BEFORE INSTABILITY WPRE
 STEP 4 CYCLE 6 OF BLOCK 5743 { 1-TH MIX 1-TH TIME }
 C= 1.250107

Remarks:

This printout indicated that if the design limit stress is used in the instability criteria, the crack will become unstable after the application of $5782 \times 57 + 3 = 329,577$ cycles of loading.

SAMPLE CASE FOR SURFACE FLAW
 THE CRACK AT THE BEGINNING OF BLOCK 5833 C = 1.7118E7
 STEP CYCLES 6 UC/DN DELTCK KMAX-G SIGMAX R SIGMAX (EFF) (EFF)

 INSTABILITY OCCURRED BY APPLIED KMAX NOT KLIMIT ***
 KMAX= 65.637 IS GREATER THAN KSURF 65.000
 VALUES BEFORE INSTABILITY WERE
 STEP 11 OF BLOCK 5833 (1-TH MIX 1-TH TIME)
 C= 1.7118E7

Remarks: This printout indicated that the instability occurred
 when the maximum spectrum stress was applied. The total
 crack growth life is $5832 \times 57 + 10 = 332,434$ cycles.

SAMPLE CASE FOR SURFACE FLAW

ANALYSIS IS DONE WITH LOAD INTERACTION

CRACK LENGTH SUMMARY TABLE FOR EVERY 39 BLOCKS

INITIAL CRACK DEPTH WAS A= .1000
INITIAL CRACK LENGTH WAS C= .1000

A	.1003	.1005	.1013	.1016	.1020	.1023	.1026	.1030	.1033
C	.1005	.1012	.1019	.1024	.1029	.1034	.1039	.1044	.1049
A	.1037	.1040	.1040	.1051	.1055	.1059	.1063	.1067	.1070
C	.1055	.1060	.1071	.1076	.1081	.1087	.1092	.1098	.1104
A	.1074	.1079	.1087	.1091	.1095	.1099	.1104	.1109	.1112
C	.1110	.1115	.1127	.1133	.1139	.1145	.1152	.1158	.1164
A	.1117	.1121	.1131	.1136	.1140	.1145	.1150	.1155	.1160
C	.1171	.1177	.1190	.1197	.1204	.1211	.1218	.1225	.1232
A	.1165	.1171	.1181	.1187	.1192	.1198	.1203	.1209	.1215
C	.1239	.1246	.1261	.1268	.1276	.1284	.1291	.1299	.1307
A	.1221	.1227	.1239	.1246	.1252	.1259	.1265	.1272	.1279
C	.1315	.1324	.1340	.1349	.1358	.1367	.1376	.1385	.1394
A	.1286	.1293	.1307	.1314	.1322	.1329	.1337	.1344	.1352
C	.1403	.1413	.1433	.1443	.1453	.1463	.1474	.1484	.1495
A	.1360	.1369	.1385	.1394	.1403	.1412	.1421	.1432	.1440
C	.1506	.1514	.1541	.1552	.1564	.1577	.1589	.1602	.1615

A	.1449	.1459	.1480	.1490	.1501	.1512	.1523	.1534	.1546
C	.1628	.1640	.1670	.1684	.1693	.1714	.1729	.1745	.1761
A	.1558	.1570	.1595	.1608	.1621	.1635	.1649	.1653	.1670
C	.1770	.1795	.1830	.1849	.1868	.1887	.1907	.1927	.1943
A	.1593	.1759	.1741	.1759	.1776	.1794	.1813	.1830	.1852
C	.1970	.1990	.2039	.2053	.2088	.2114	.2141	.2169	.2190
A	.1572	.1604	.1638	.1662	.1686	.2012	.2038	.2066	.2074
C	.2229	.2260	.2327	.2362	.2399	.2434	.2479	.2520	.2565
A	.2124	.2155	.2222	.2258	.2296	.2336	.2377	.2421	.2467
C	.2611	.2660	.2767	.2825	.2885	.2952	.3022	.3096	.3175
A	.3275	.3414	.3733	.3915	.4115	.4337	.4584	.4861	.5174
C	.5532	.5946	.7007	.7712	.8599	.9770	1.1438	1.4230	

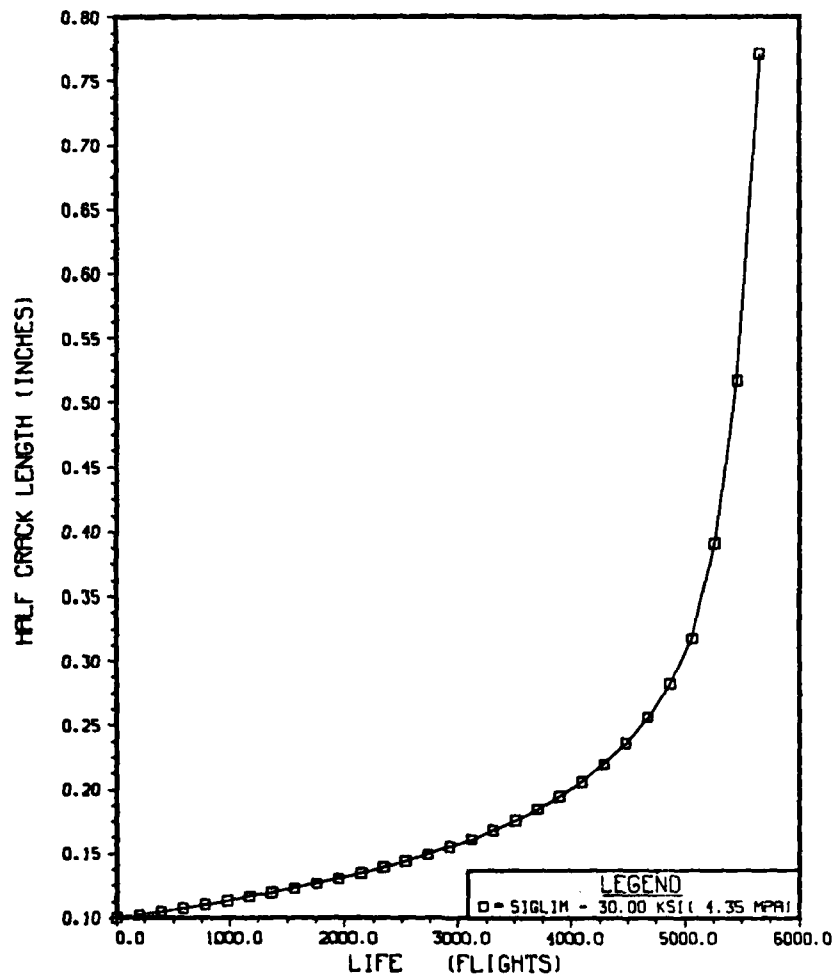
CRITICAL CRACK IS: C=1.7132IN BLOCK 5473 STEP 11 CYCLE 0. (1-TH MIX 1-TH TIME)

DETAILED FATIGUE CRACK GROWTH ANALYSIS PROGRAM C P K G R D

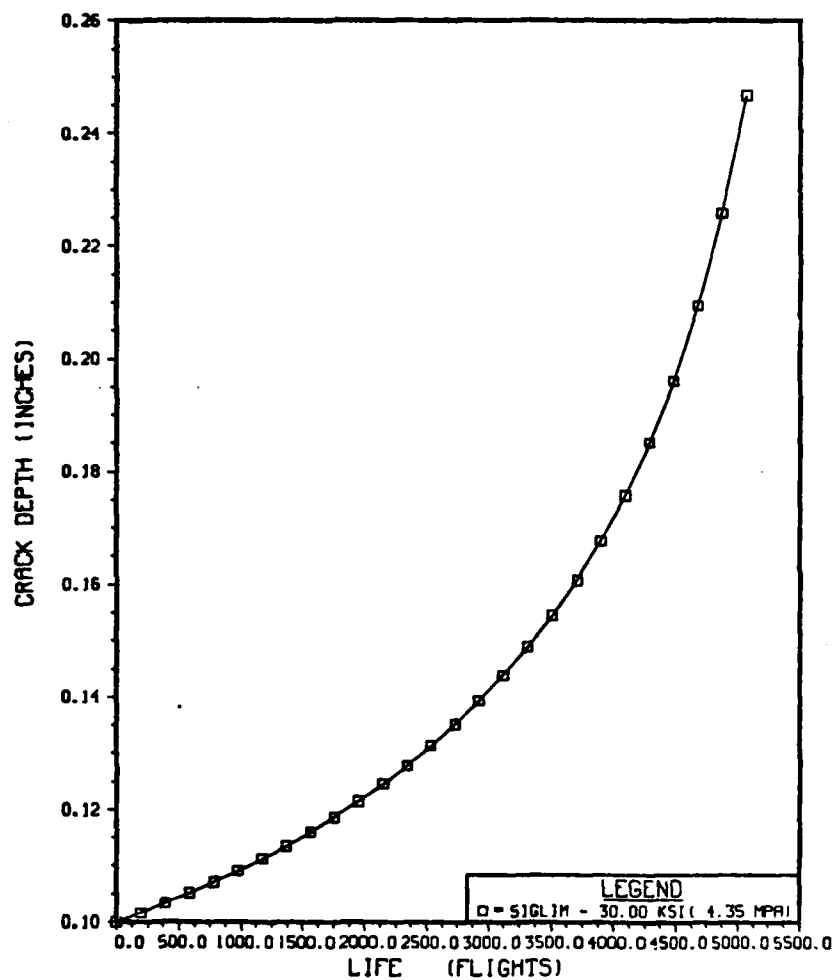
***** F-O-F OR INPUT UNIT *****

Remarks: Above is the summary crack growth table which can be directly used in the crack growth analysis report.

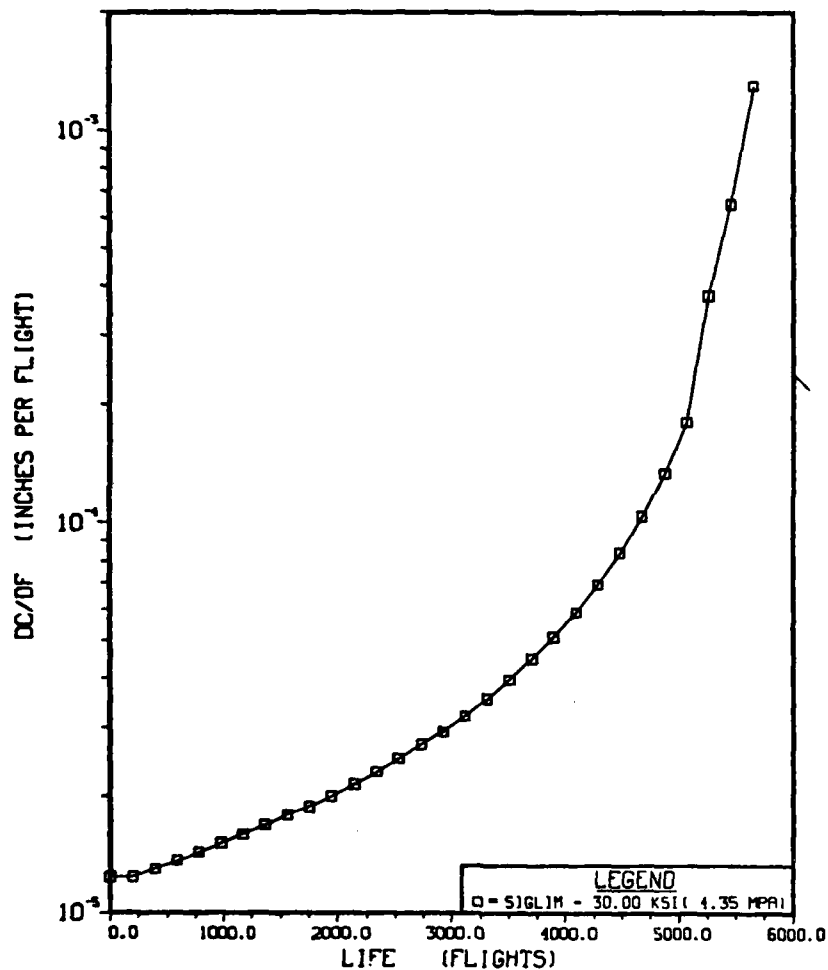
CRKGRO PROGRAM CRACK GROWTH ANALYSIS
 SAMPLE CASE FOR SURFACE FLAW
 LOAD INTERACTION CONSIDERED



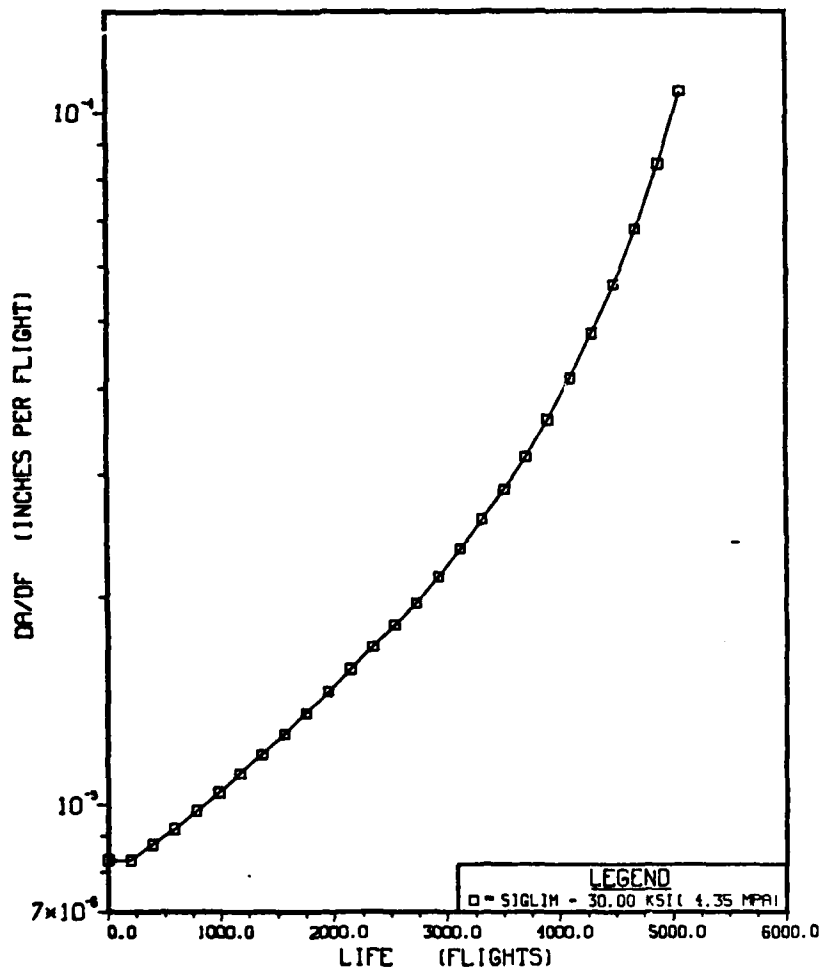
CRKGRO PROGRAM CRACK GROWTH ANALYSIS
 SAMPLE CASE FOR SURFACE FLAW
 LOAD INTERACTION CONSIDERED



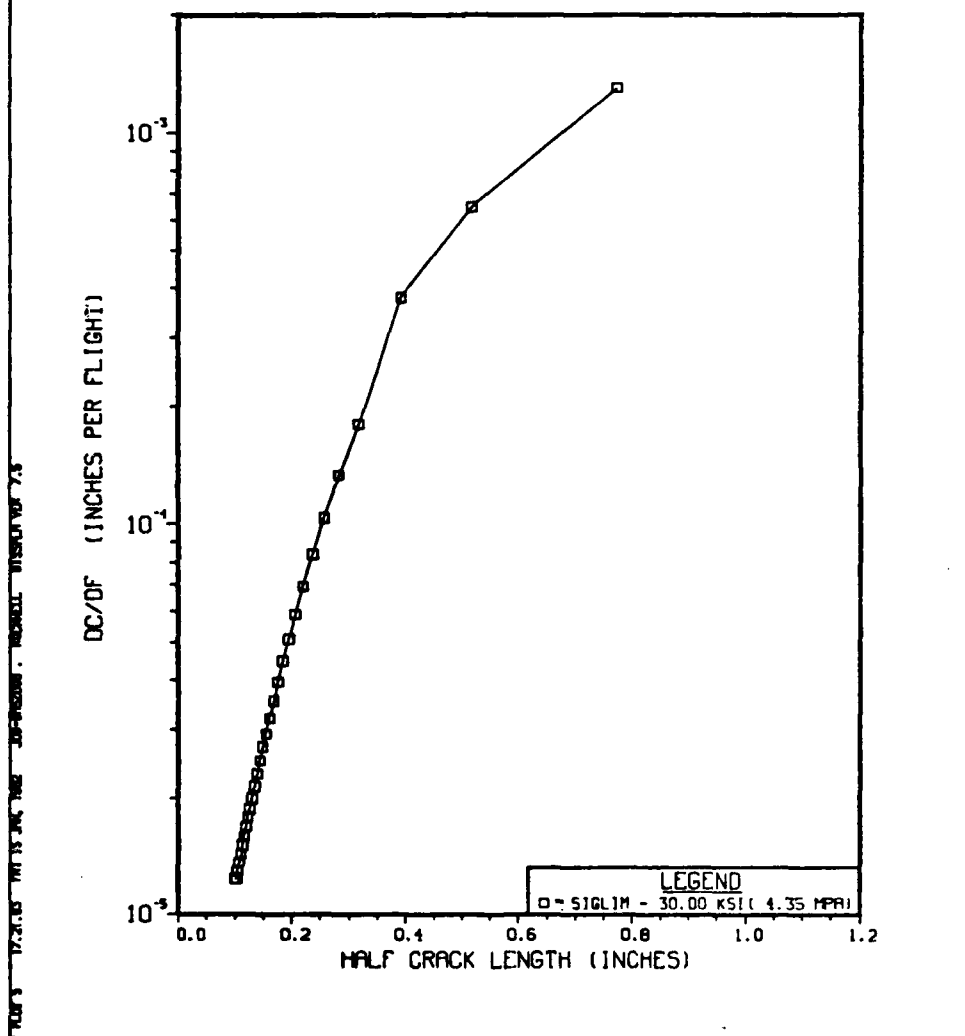
CRKGRO PROGRAM CRACK GROWTH ANALYSIS
 SAMPLE CASE FOR SURFACE FLAW
 LOAD INTERACTION CONSIDERED



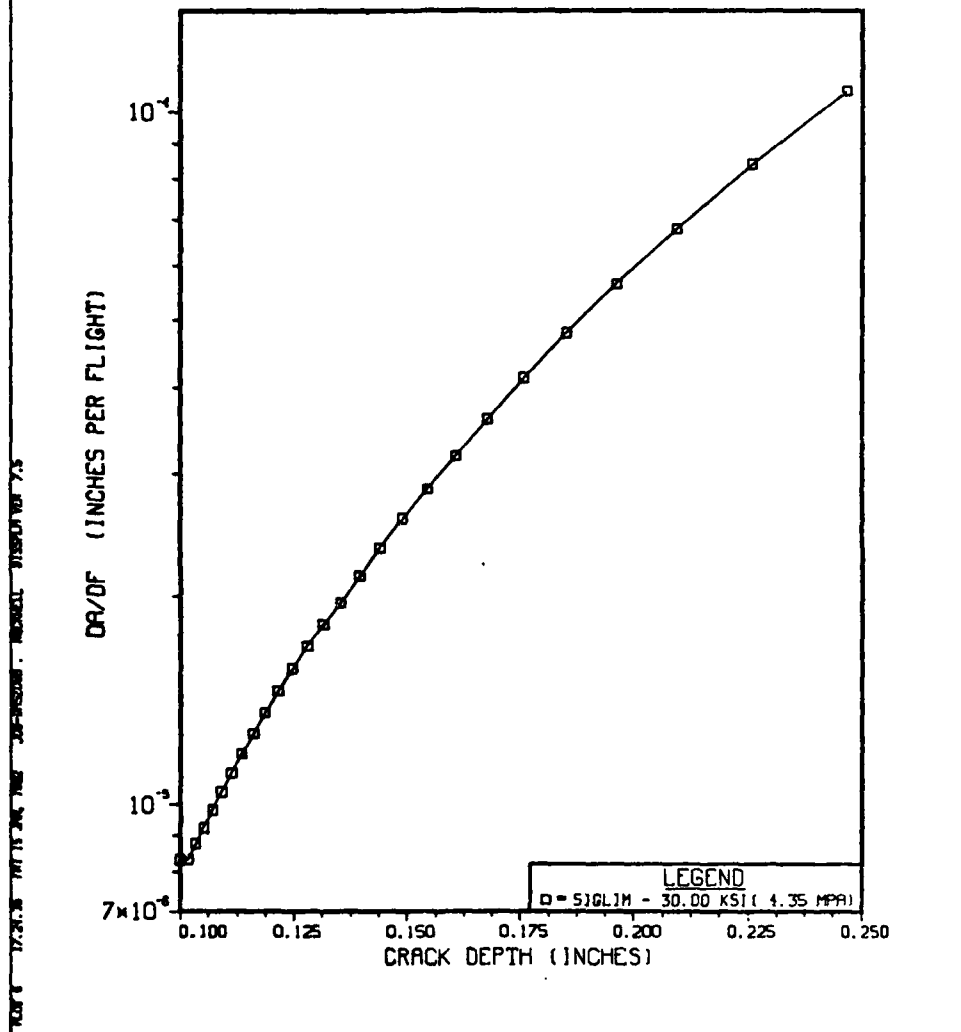
CRKGRO PROGRAM CRACK GROWTH ANALYSIS
 SAMPLE CASE FOR SURFACE FLAW
 LOAD INTERACTION CONSIDERED



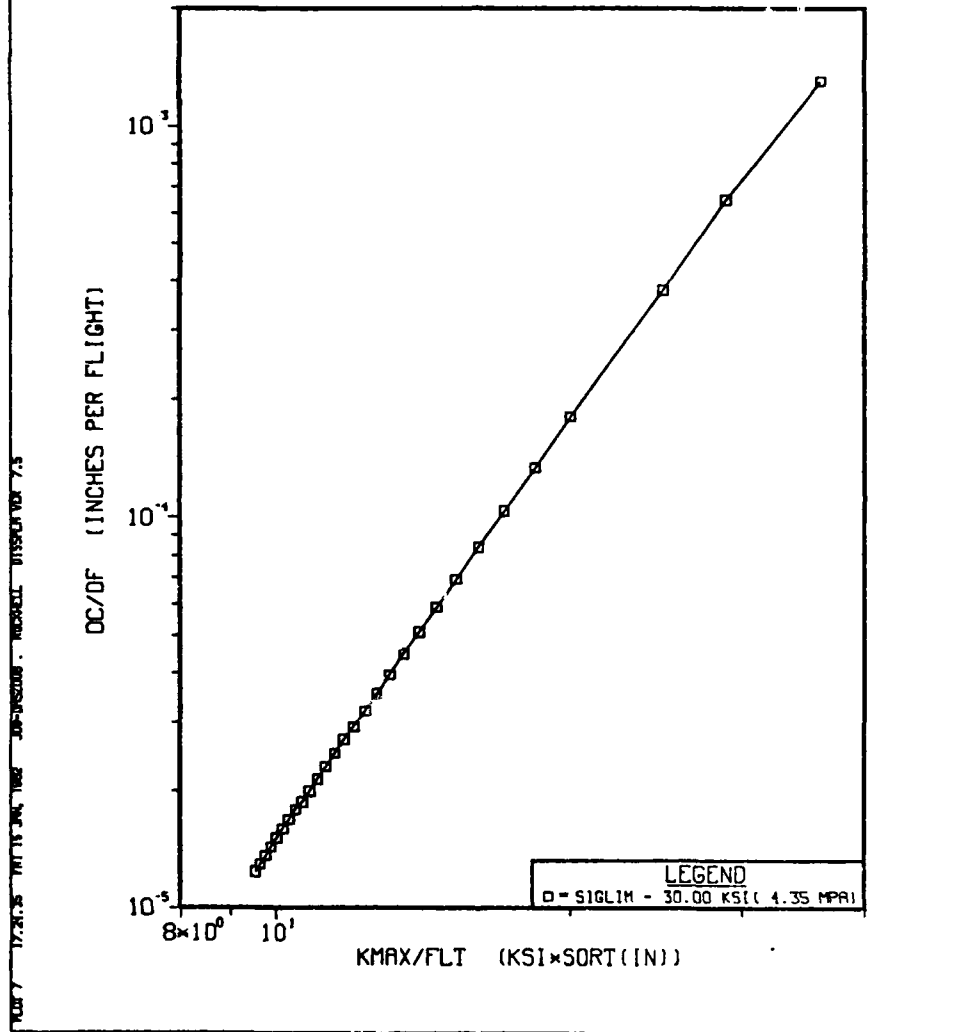
CRKGRO PROGRAM CRACK GROWTH ANALYSIS
 SAMPLE CASE FOR SURFACE FLAW
 LOAD INTERACTION CONSIDERED



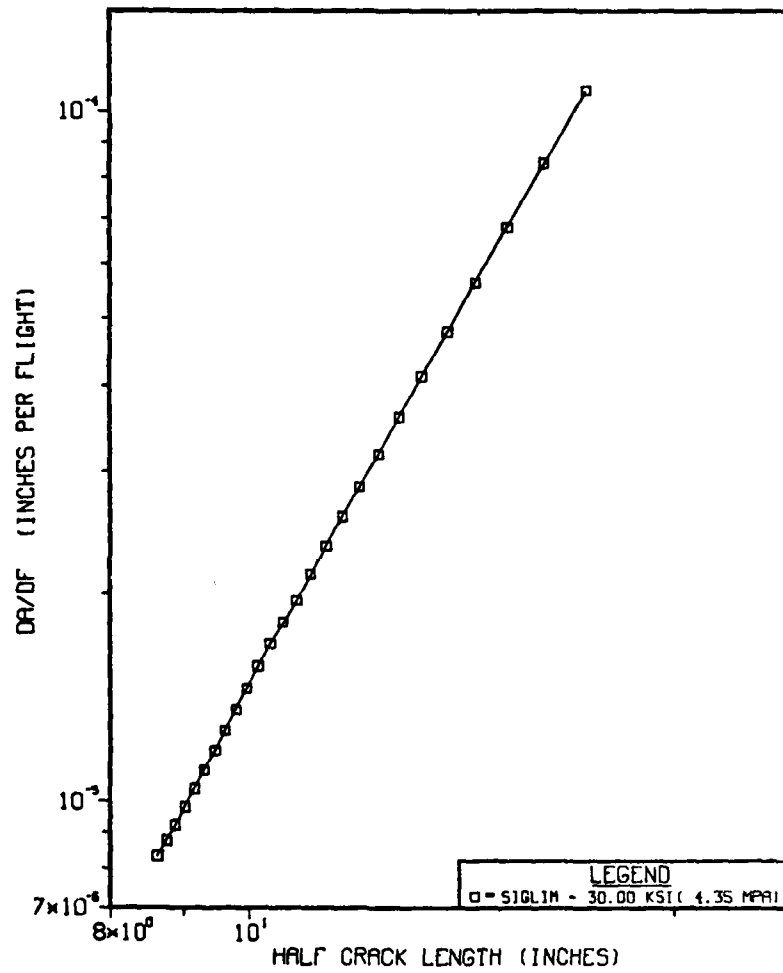
CRKGRO PROGRAM CRACK GROWTH ANALYSIS
 SAMPLE CASE FOR SURFACE FLAW
 LOAD INTERACTION CONSIDERED



CRKGRO PROGRAM CRACK GROWTH ANALYSIS
 SAMPLE CASE FOR SURFACE FLAW
 LOAD INTERACTION CONSIDERED



CRKGRO PROGRAM CRACK GROWTH ANALYSIS
 SAMPLE CASE FOR SURFACE FLAW
 LOAD INTERACTION CONSIDERED



The second example is a test data correlation case. Test data were generated in Phase III experimental verification program (Ref. 12). The test specimen in this example case is shown in figure 5, which is a 2219-T851 aluminum center-crack-tension (CCT) specimen. It is a standard ASTM specimen used for da/dN testing. The initial half crack length was $c_i = 0.148$ in, which was the measured dimension after the application of 20,000 constant amplitude precracking cycles. The test specimen was the fighter air-to-ground (A-G) mission generated in Phase III of this research and development work. Appendix C contains the peaks and valleys of the test spectrum in the percentage of the design limit stress ($\% \sigma_{lim}$) format.

Since the crack was a center through-crack, crack code 2010 was called-out. The crack-growth-rate constants and load interaction model parameters used in the prediction were as follows. In this example, the single-slope crack growth rate data was used.

$$\begin{aligned} C &= 5.066 \times 10^{-10} \text{ (in ksi unit)} & q &= 1.0 \\ n &= 3.83 & R_{cut}^+ &= +0.75 \\ m &= 0.6 & R_{cut}^- &= -0.75 \\ K_{th_0} &= 2.5 \text{ ksi} \sqrt{\text{in.}} & A &= 1.0 \\ K_C &= 65 \text{ ksi} \sqrt{\text{in.}} & \sigma_{ty} &= 48 \text{ ksi} \\ R_{so} &= 3.0 \end{aligned}$$

Both the load-interaction and no load-interaction options were executed in this example in order to illustrate the spectrum load interaction effects. For the load interaction solution option, CRKGRO predicted the crack-growth life was $N_p = 19 \times 263 + 1,452/19 = 5,073$ flights, or $19 \times 4,997 + 1452 = 96,395$ cycles. Compared to the test result ($N_T = 5,403$ flights), the prediction ratio is $N_p/N_T = 0.94$. The no load interaction prediction was $N_p = 3,948$ flights (75,016 cycles), compared to the test result, $N_p/N_T = 0.73$.

All the input echoes and the print-outs of the outputs are shown in the next few pages.

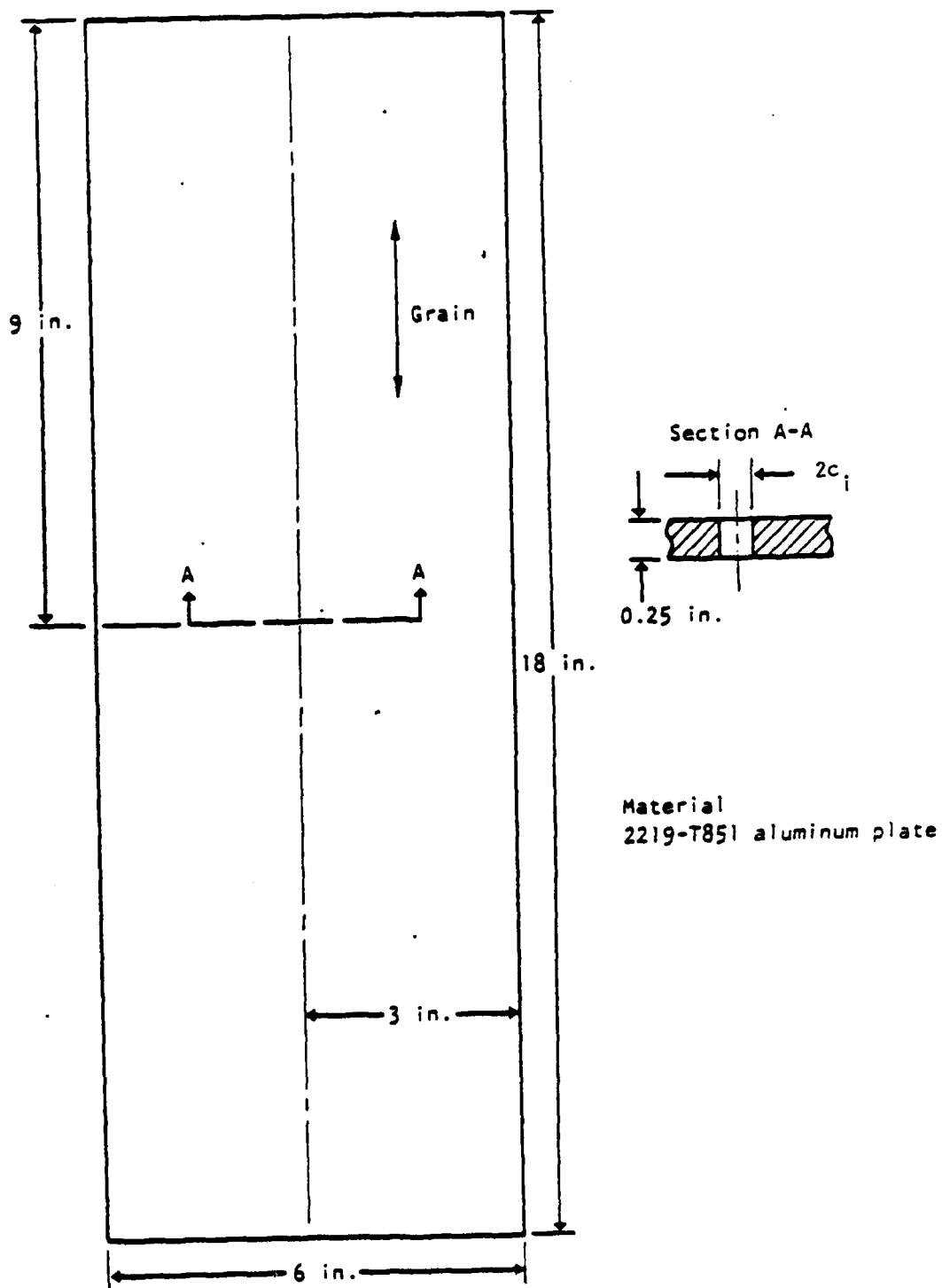


Figure 5. Test Specimen Configuration

TITLE			
F-8-2 AIR-TO-GROUND SPECTRUM, BASELINE			
END			
MATERIAL 2219-T851 ALUMINUM			
5.066	-10	3.83	
65.	45.	46.	1.0
THRESHOLD 1.			
2.5			
LIMITS			
1.45		.75	-.75
ANALYSIS			
INTERSECTION		BOTH	3.0
2.010	6.	.25	
1	24.0	BY MAXIMUM	
SPECTRUM			
AIR TO GROUND SPECTRUM			
0.30	1	12	
MAX-MIN PART1			
END SPECTRUM			
MISSION =200			
263			
OUTPUT			
			50
END DATA			

DETAILED FATIGUE CRACK GROWTH ANALYSIS PROGRAM C R K 6 R O

F-B-2 AIR-TO-GROUND SPECTRUM, EASELINE

CRACK CODE 2030 --- THROUGH CRACK, CENTERED

LOAD INTERACTION : WILLENBORG-CHANG

DAMAGE ACCUMULATION VROMAN (LINEAR APPRX.)
CRACK GROWTH RATE EQ. MODIFIED WALKER
ANALYSIS IS PERFORMED WITH A SPECTRUM THAT HAS BEEN RANGED PAIRED.

INSTABILITY WILL BE BASED ON MAXIMUM STRESS

MATERIAL : 2219-1851 ALUMINUM

FRACTURE TOUGHNESS	DEPTH	LENGTH
GROWTH RATE EQ. CONST. C	DIRECTION	DIRECTION
GROWTH RATE EQ. EXP. N	45.000	65.000
	0.	5.0660E-10
	0.0100	3.8300

GROWTH RATE EQ. EXP. M	.6000
GROWTH RATE EQ. EXP. Q	1.0100

YIELD STRENGTH 48.000

DELTA KTH = (1 - 1.0) * 9) * 2.501

+R CUT-OFF = .75
-R CUT-OFF = -.75

RETARDATION SHUT-OFF RATIO FOR CRACK ARREST = 3.0000

HALF PLATE WIDTH (B) = 3.000
PLATE THICKNESS (AT) = .250

INITIAL HALF CRACK LENGTH (C) = .1450

M I S S I O N M I

MAXIMUM NUMBER OF LOAD BLOCKS = 200
THE LOADING SPECTRUM HAS 1 MISSION(S)
DESIGN LIMIT STRESS = 24.000 (KSI)

***** END OF INPUT *****

F-8-2 AIR-TO-GROUND SPECTRUM, BASELINE

02/06/81

ESTIMATION OF THE CRITICAL CRACK LENGTH
BASED ON K-LIMIT AND CONSTANT ASPECT RATIO

ITERATION	CRACK SIZE	STRESS INTENSITY (LIMIT)	STRESS INTENSITY CORRECTION FACTOR
1	0.1450	16.222	1.0014
2	2.9850	29.317	1.12840
3	1.5650	64.479	1.2103
4	2.2750	105.412	1.6428
5	1.9200	86.524	1.3661
6	1.7425	71.726	1.2784
7	1.6538	67.959	1.2423
8	1.6394	66.153	1.2258
9	1.5872	65.274	1.2180

APPROXIMATE CRITICAL CRACK (A OR C) = 1.567
WHEN K-LIMIT IS WITHIN A 0.5% TOLERANCE OF K CRITICAL

F-6-2 AIR-TO-GROUND SPECTRUM, BASELINE									
THE CRACK AT THE BEGINNING OF BLOCK 1 C = .145000 02/06/81									
STEP	CYCLES	C	DC/MN	DELICK	KMAX-C	SIGMAX	R	SIGMAX (EFF)	R (EFF)
2950	1	1	7.84	4.43	2.85	8.670	2.0	4.141	56
2951	1	1	2.64	6.12	1.95	9.720	.08	5.740	55
2952	1	1	4.45	3.26	6.4	13.140	.39	9.520	16
2953	1	1	4.45	3.26	4.15	10.770	.57	6.441	33
2954	1	1	4.45	3.26	2.91	15.170	.27	1.398	23
2955	1	1	4.45	3.26	1.86	15.170	.16	18.051	75
2956	1	1	4.45	3.26	1.11	17.050	.11	3.668	13
2957	1	1	4.45	3.26	2.41	11.040	.30	6.453	33
2958	1	1	4.45	3.26	4.50	12.720	.07	9.453	13
2959	1	1	4.45	3.26	6.53	13.830	.07	10.808	19
2960	1	1	4.45	3.26	7.43	13.830	.49	10.574	15
2961	1	1	4.45	3.26	1.39	18.030	.01	16.636	10
2962	1	1	4.45	3.26	1.44	18.120	.01	18.060	13
2963	1	1	4.45	3.26	1.54	11.560	.02	10.243	27
2964	1	1	4.45	3.26	1.04	13.350	.02	18.926	14
2965	1	1	4.45	3.26	1.14	12.350	.22	5.819	35
2966	1	1	4.45	3.26	1.40	12.050	.09	5.664	44
2967	1	1	4.45	3.26	3.89	9.660	.07	7.673	38
2968	1	1	4.45	3.26	3.25	9.150	.07	7.634	75
2969	1	1	4.45	3.26	2.68	11.310	.27	9.94	34
2970	1	1	4.45	3.26	1.68	14.710	.27	4.942	26
2971	1	1	4.45	3.26	1.40	10.020	.09	7.492	37
2972	1	1	4.45	3.26	1.15	11.230	.07	2.554	25
2973	1	1	4.45	3.26	1.76	7.830	.47	2.110	67
2974	1	1	4.45	3.26	1.07	15.690	.46	13.201	47
2975	1	1	4.45	3.26	1.07	15.980	.19	7.933	25
2976	1	1	4.45	3.26	1.64	14.980	.29	7.561	24
2977	1	1	4.45	3.26	1.20	11.400	.18	4.047	16
2978	1	1	4.45	3.26	1.28	11.090	.48	17.489	12
2979	1	1	4.45	3.26	1.35	14.670	.44	3.404	35
2980	1	1	4.45	3.26	1.54	11.310	.38	7.425	45
2981	1	1	4.45	3.26	1.10	11.190	.10	7.963	45
2982	1	1	4.45	3.26	1.47	11.490	.00	4.503	34
2983	1	1	4.45	3.26	1.10	16.310	.18	14.782	27
2984	1	1	4.45	3.26	1.68	16.870	.76	11.323	20
2985	1	1	4.45	3.26	1.27	14.650	.05	19.674	24
2986	1	1	4.45	3.26	1.65	13.630	.05	7.160	36
2987	1	1	4.45	3.26	4.94	12.160	.22	19.653	45
2988	1	1	4.45	3.26	6.01	11.430	.47	11.743	34
2989	1	1	4.45	3.26	6.80	11.350	.57	8.165	27
2990	1	1	4.45	3.26	1.63	12.510	.47	11.675	34
2991	1	1	4.45	3.26	1.55	12.510	.37	11.675	34
2992	1	1	4.45	3.26	1.71	11.620	.64	11.675	34
2993	1	1	4.45	3.26	1.71	11.620	.64	11.675	34
2994	1	1	4.45	3.26	1.71	11.620	.64	11.675	34
2995	1	1	4.45	3.26	1.71	11.620	.64	11.675	34

F-B-2 AIK-TU-GROUND SPECTRUM, BASELINE									
THE CRACK AT THE BEGINNING OF BLOCK 1 C = .145000 02/06/81									
STEP	CYCLES	C	CC/UN	DELTK	KMAX-C	SIGMAX	R	SIGMAX (EFF)	R (EFF)
2996	1.	1492	0.147E-06	3.035	1.308	6.780	.003	1.889	.75
2997	1.	1492	0.744E-07	10.208	1.465	14.940	.063	12.342	.260
2998	1.	1492	0.744E-07	7.553	1.091	10.920	.005	7.409	.250
4946	1.	1522	0.744E-06	3.540	1.091	10.920	.005	7.409	.013
4947	1.	1522	0.744E-06	10.621	1.091	10.920	.005	7.409	.013
4948	1.	1522	0.744E-06	2.315	1.091	10.920	.005	7.409	.013
4949	1.	1522	0.744E-06	1.422	1.091	10.920	.005	7.409	.013
4950	1.	1522	0.744E-06	1.422	1.091	10.920	.005	7.409	.013
4951	1.	1522	0.744E-06	1.422	1.091	10.920	.005	7.409	.013
4952	1.	1522	0.744E-06	1.422	1.091	10.920	.005	7.409	.013
4953	1.	1522	0.744E-06	1.422	1.091	10.920	.005	7.409	.013
4954	1.	1522	0.744E-06	1.422	1.091	10.920	.005	7.409	.013
4955	1.	1522	0.744E-06	1.422	1.091	10.920	.005	7.409	.013
4956	1.	1522	0.744E-06	1.422	1.091	10.920	.005	7.409	.013
4957	1.	1522	0.744E-06	1.422	1.091	10.920	.005	7.409	.013
4958	1.	1522	0.744E-06	1.422	1.091	10.920	.005	7.409	.013
4959	1.	1522	0.744E-06	1.422	1.091	10.920	.005	7.409	.013
4960	1.	1522	0.744E-06	1.422	1.091	10.920	.005	7.409	.013
4961	1.	1522	0.744E-06	1.422	1.091	10.920	.005	7.409	.013
4962	1.	1522	0.744E-06	1.422	1.091	10.920	.005	7.409	.013
4963	1.	1522	0.744E-06	1.422	1.091	10.920	.005	7.409	.013
4964	1.	1522	0.744E-06	1.422	1.091	10.920	.005	7.409	.013
4965	1.	1522	0.744E-06	1.422	1.091	10.920	.005	7.409	.013
4966	1.	1522	0.744E-06	1.422	1.091	10.920	.005	7.409	.013
4967	1.	1522	0.744E-06	1.422	1.091	10.920	.005	7.409	.013
4968	1.	1522	0.744E-06	1.422	1.091	10.920	.005	7.409	.013
4969	1.	1522	0.744E-06	1.422	1.091	10.920	.005	7.409	.013
4970	1.	1522	0.744E-06	1.422	1.091	10.920	.005	7.409	.013
4971	1.	1522	0.744E-06	1.422	1.091	10.920	.005	7.409	.013
4972	1.	1522	0.744E-06	1.422	1.091	10.920	.005	7.409	.013
4973	1.	1522	0.744E-06	1.422	1.091	10.920	.005	7.409	.013
4974	1.	1522	0.744E-06	1.422	1.091	10.920	.005	7.409	.013
4975	1.	1522	0.744E-06	1.422	1.091	10.920	.005	7.409	.013
4976	1.	1522	0.744E-06	1.422	1.091	10.920	.005	7.409	.013
4977	1.	1522	0.744E-06	1.422	1.091	10.920	.005	7.409	.013
4978	1.	1522	0.744E-06	1.422	1.091	10.920	.005	7.409	.013
4979	1.	1522	0.744E-06	1.422	1.091	10.920	.005	7.409	.013
4980	1.	1522	0.744E-06	1.422	1.091	10.920	.005	7.409	.013
4981	1.	1522	0.744E-06	1.422	1.091	10.920	.005	7.409	.013
4982	1.	1522	0.744E-06	1.422	1.091	10.920	.005	7.409	.013
4983	1.	1522	0.744E-06	1.422	1.091	10.920	.005	7.409	.013
4984	1.	1522	0.744E-06	1.422	1.091	10.920	.005	7.409	.013
4985	1.	1522	0.744E-06	1.422	1.091	10.920	.005	7.409	.013
4986	1.	1522	0.744E-06	1.422	1.091	10.920	.005	7.409	.013
4987	1.	1522	0.744E-06	1.422	1.091	10.920	.005	7.409	.013

F-B-2 AIR-TO-GROUND SPECTRUM, BASELINE

THE CRACK AT THE BEGINNING OF BLOCK		1	C = .145000		02/06/81				
STEP	CYCLES	C	DC/ON	DELTK	KMAX-C	SIGMAX	R	SIGMAX (EFF)	R (EFF)
4988	1.	.1523	2.35	E-06	9.67	1.63	14.430	.04	12.427
4989	1.	.1523	2.50	E-07	6.06	4.05	9.120	.04	5.828
4990	1.	.1523	1.04	E-07	4.81	3.18	8.190	.15	4.574
4991	1.	.1523	2.35	E-08	14.38	1.78	17.780	.35	2.868
4992	1.	.1523	4.72	E-08	3.90	2.09	15.850	.17	3.012
4993	1.	.1523	2.02	E-06	9.85	1.51	14.260	.01	12.250
4994	1.	.1523	2.02	E-06	2.10	1.45	7.020	.57	2.085
4995	1.	.1523	0.						

THE CRACK AT THE END OF BLOCK 1 IS .152278


```

F-8-2      AIR-TO-GROUND SPECTRUM, BASELINE
THE CRACK AT THE BEGINNING OF BLOCK 20      C =1.327377      02/06/81
STEP CYCLES C      DC/DN      DELTCK KMAX-C      SIGMAX      R      SIGMAX      R
              (EFF) (EFF)
*****
AT FRACTIONAL (.7-.8) OR (.9) KSUBC OF 58.500
KLIMIT=58.523      C=1.39653
IN BLOCK 20      SEGMT 1 ( 1-TH TIME)      STEP 386      CYCLE 0.0
*****
*****
KLIMIT=65.006      IS GREATER THAN KSUBC= 65.000
VALUES BEFORE INSTABILITY WERE
STEP 1123      OF BLOCK 20      SEGMT 1 ( 1-TH TIME)
C= 1.572493
*****
*****
***** INSTABILITY OCCURRED BY APPLIED KMAX NOT KLIMIT *****
KMAX= 68.063      IS GREATER THAN KSUEC= 65.000
VALUES BEFORE INSTABILITY WERE
STEP 1452      OF BLOCK 20      SEGMT 1 ( 1-TH TIME)
C= 1.684931
*****

```

F-B-2 AIR-TO-GROUND SPECTRUM. BASELINE

02/06/81

ANALYSIS IS DONE WITH LOAD INTERACTION

CRACK GROWTH SUMMARY TABLE FOR EVERY 1 BLOCKS

INITIAL CRACK LENGTH WAS C= .1450

C	.1523	.1603	.1691	.1750	.1899	.2023	.2162	.2322	.2506	.2721
C	.2975	.3267	.3652	.4120	.4726	.5553	.6759	.8756	1.3274	

CRITICAL CRACK IS: C=1.6849IN BLOCK 20 STEP 1452 CYCLE 0.

AD-A118 968

ROCKWELL INTERNATIONAL EL SEGUNDO CA NORTH AMERICAN --ETC F/6 9/2
A USER'S MANUAL FOR A DETAILED LEVEL FATIGUE CRACK GROWTH ANALY--ETC(U)
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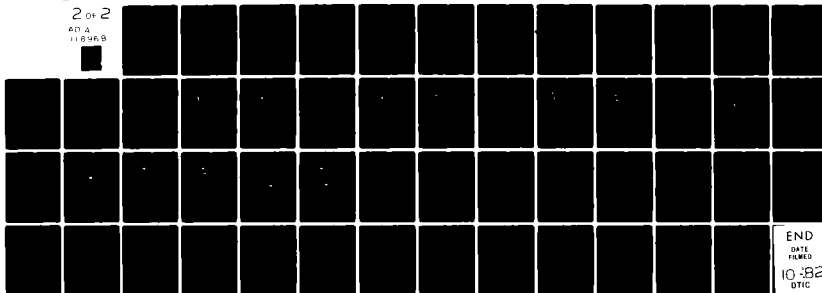
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2 OF 2

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KERUR CASE WITH NO LOAD INTERACTION FOR SIGMA-LIMIT = 24.00

F-B-2 AIR-TO-GROUND SPECTRUM, BASELINE									
THE CRACK AT THE BEGINNING OF BLOCK 1 C = .145000 72/06/R1									
STEP	CYCLES	C	DC/PW	DELICK	KMAX-C	SIGMAX	R	SIGMAX (EFF)	R (EFF)
2950	1.	1505	2.43	4.45	1.98	8.670	.26	8.670	.26
2951	1.	1505	6.08	6.15	1.71	9.720	.39	9.720	.39
2952	1.	1505	8.27	5.49	1.40	13.140	.57	13.140	.57
2953	1.	1505	9.77	3.21	1.35	15.770	.70	15.770	.70
2954	1.	1505	9.77	1.88	1.23	15.770	.70	15.770	.70
2955	1.	1505	9.77	1.88	1.23	15.770	.70	15.770	.70
2956	1.	1505	9.77	1.88	1.23	15.770	.70	15.770	.70
2957	1.	1505	9.77	1.88	1.23	15.770	.70	15.770	.70
2958	1.	1505	9.77	1.88	1.23	15.770	.70	15.770	.70
2959	1.	1505	9.77	1.88	1.23	15.770	.70	15.770	.70
2960	1.	1505	9.77	1.88	1.23	15.770	.70	15.770	.70
2961	1.	1505	9.77	1.88	1.23	15.770	.70	15.770	.70
2962	1.	1505	9.77	1.88	1.23	15.770	.70	15.770	.70
2963	1.	1505	9.77	1.88	1.23	15.770	.70	15.770	.70
2964	1.	1505	9.77	1.88	1.23	15.770	.70	15.770	.70
2965	1.	1505	9.77	1.88	1.23	15.770	.70	15.770	.70
2966	1.	1505	9.77	1.88	1.23	15.770	.70	15.770	.70
2967	1.	1505	9.77	1.88	1.23	15.770	.70	15.770	.70
2968	1.	1505	9.77	1.88	1.23	15.770	.70	15.770	.70
2969	1.	1505	9.77	1.88	1.23	15.770	.70	15.770	.70
2970	1.	1505	9.77	1.88	1.23	15.770	.70	15.770	.70
2971	1.	1505	9.77	1.88	1.23	15.770	.70	15.770	.70
2972	1.	1505	9.77	1.88	1.23	15.770	.70	15.770	.70
2973	1.	1505	9.77	1.88	1.23	15.770	.70	15.770	.70
2974	1.	1505	9.77	1.88	1.23	15.770	.70	15.770	.70
2975	1.	1505	9.77	1.88	1.23	15.770	.70	15.770	.70
2976	1.	1505	9.77	1.88	1.23	15.770	.70	15.770	.70
2977	1.	1505	9.77	1.88	1.23	15.770	.70	15.770	.70
2978	1.	1505	9.77	1.88	1.23	15.770	.70	15.770	.70
2979	1.	1505	9.77	1.88	1.23	15.770	.70	15.770	.70
2980	1.	1505	9.77	1.88	1.23	15.770	.70	15.770	.70
2981	1.	1505	9.77	1.88	1.23	15.770	.70	15.770	.70
2982	1.	1505	9.77	1.88	1.23	15.770	.70	15.770	.70
2983	1.	1505	9.77	1.88	1.23	15.770	.70	15.770	.70
2984	1.	1505	9.77	1.88	1.23	15.770	.70	15.770	.70
2985	1.	1505	9.77	1.88	1.23	15.770	.70	15.770	.70
2986	1.	1505	9.77	1.88	1.23	15.770	.70	15.770	.70
2987	1.	1505	9.77	1.88	1.23	15.770	.70	15.770	.70
2988	1.	1505	9.77	1.88	1.23	15.770	.70	15.770	.70
2989	1.	1505	9.77	1.88	1.23	15.770	.70	15.770	.70
2990	1.	1505	9.77	1.88	1.23	15.770	.70	15.770	.70
2991	1.	1505	9.77	1.88	1.23	15.770	.70	15.770	.70
2992	1.	1505	9.77	1.88	1.23	15.770	.70	15.770	.70
2993	1.	1505	9.77	1.88	1.23	15.770	.70	15.770	.70
2994	1.	1505	9.77	1.88	1.23	15.770	.70	15.770	.70
2995	1.	1505	9.77	1.88	1.23	15.770	.70	15.770	.70

F-B-2 AIR-TO-GROUND SPECTRUM, BASELINE									
THE CRACK AT THE BEGINNING OF BLOCK									
STEP	CYCLES	C	DC/DN	DELICK	KMAX-C	SIGMAX	R	C = .145000	02/06/81
						SIGMAX	R		SIGMAX
						(EFF)			(EFF)
2996	1.	15055	63331	304	1668	6.780	303	5	6.780
2997	1.	15055	63331	12.299	16329	14.940	603	303	14.940
2998	1.	15055	63331	7.57	7.54	18.100	0	303	18.100
4946	1.	15433	11572	10.68	6.44	19.210	0.45	0	19.210
4947	1.	15433	11572	2.37	1.18	15.990	0.27	0.45	15.990
4948	1.	15433	11572	4.37	4.47	6.390	0.47	0.27	6.390
4949	1.	15433	11572	3.44	4.08	8.700	0.43	0.47	8.700
4951	1.	15444	11572	14.68	6.68	21.000	0	0.43	21.000
4952	1.	15444	11572	6.92	7.08	11.160	0.23	0	11.160
4953	1.	15444	11572	6.15	6.52	13.670	0.35	0.23	13.670
4954	1.	15444	11572	13.05	6.22	14.460	0.46	0.35	14.460
4955	1.	15444	11572	13.97	6.90	9.870	0.28	0.46	9.870
4956	1.	15444	11572	4.36	6.29	11.850	0.30	0.28	11.850
4957	1.	15444	11572	8.39	6.09	21.300	0	0.30	21.300
4958	1.	15444	11572	12.22	1.10	15.870	0.80	0	15.870
4959	1.	15444	11572	3.34	1.54	17.920	0.31	0.80	17.920
4961	1.	15444	11572	4.59	1.96	12.150	0.23	0.31	12.150
4962	1.	15444	11572	3.48	1.40	9.090	0.61	0.23	9.090
4963	1.	15444	11572	2.99	1.36	7.630	0.40	0.61	7.630
4964	1.	15444	11572	9.23	1.48	16.110	0.13	0.40	16.110
4965	1.	15444	11572	9.35	1.27	16.980	0.32	0.13	16.980
4966	1.	15444	11572	10.95	1.24	16.350	0.33	0.32	16.350
4967	1.	15444	11572	8.73	1.98	12.840	0.01	0.33	12.840
4968	1.	15444	11572	3.84	1.56	10.620	0.48	0.01	10.620
4971	1.	15444	11572	17.15	7.43	14.610	0	0.48	14.610
4972	1.	15444	11572	12.56	7.22	17.310	0	0	17.310
4973	1.	15444	11572	5.60	1.33	13.200	0.72	0	13.200
4974	1.	15444	11572	4.00	1.64	8.070	0.15	0.72	8.070
4975	1.	15444	11572	11.85	1.88	7.410	0.55	0.15	7.410
4976	1.	15444	11572	4.26	1.48	14.250	0.39	0.55	14.250
4977	1.	15444	11572	2.66	1.97	16.090	0	0.39	16.090
4978	1.	15444	11572	12.00	1.64	17.160	0	0	17.160
4979	1.	15444	11572	15.85	1.26	11.980	0.28	0	11.980
4981	1.	15444	11572	4.22	1.68	10.580	0.58	0.28	10.580
4982	1.	15444	11572	2.57	1.35	13.680	0.14	0.58	13.680
4983	1.	15444	11572	2.44	1.57	15.490	0.14	0.14	15.490
4984	1.	15444	11572	6.00	1.53	18.670	0.12	0.14	18.670
4985	1.	15444	11572	1.81	1.06		0.21	0.12	
4986	1.	15444	11572						

F-8-2 AIR-TO-GROUND SPECTRUM, BASELINE

THE CRACK AT THE BEGINNING OF BLOCK 1 C = .145000 02/06/81

STEP	CYCLES	C	DC/ON	DELTK	KMAX-C	SIGMAX	R	SIGMAX (EFF)	R (EFF)
4988	1:	.1544	3.267E-06	9.74	16.09	14.430	.04	14.430	.04
4989	1:	.1544	5.531E-07	6.11	6.38	9.120	.04	9.120	.04
4990	1:	.1544	2.762E-07	4.85	6.73	8.190	.15	8.190	.15
4991	1:	.1544	7.433E-08	3.11	1.74	6.780	.35	6.780	.35
4992	1:	.1544	7.433E-07	12.38	14.09	5.850	.04	5.850	.04
4993	1:	.1544	1.011E-07	9.93	5.99	14.280	.01	14.280	.01
4994	1:	.1544	3.366E-06	2.12	4.91	7.020	.57	7.020	.57
4995	1:	.1544	3.255E-08						

THE CRACK AT THE END OF BLOCK 1 IS .154443

F-8-2

THE CR

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F-8-2 AIR-TO-GROUND SPECTRUM, BASELINE

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THE CRACK AT THE BEGINNING OF BLOCK      15      C = .883082      02/06/81

STEP CYCLES      C      DC/TN      DELTCK KMAX-C      SIGMAX      R      SIGMAX      R
(EFF)      (EFF)

2989      1.      1.1801      5.3347E-05      18.49      23.89      11.160      23      11.160      23
2990      1.      1.1803      2.952E-04      33.24      36.89      14.430      02      14.430      02
2991      1.      1.1804      4.986E-05      15.93      28.58      13.350      44      13.350      44
2992      1.      1.1804      2.134E-05      11.57      26.78      12.510      57      12.510      57
2993      1.      1.1804      4.263E-05      11.57      16.24      8.520      37      8.520      37
2994      1.      1.1805      1.043E-04      24.02      14.98      11.670      04      11.670      04
2995      1.      1.1805      5.312E-06      9.44      14.52      6.780      35      6.780      35
2996      1.      1.1808      2.947E-06      6.49      31.99      14.940      00      14.940      00
2997      1.      1.1808      2.947E-06      6.49      17.34      8.100      63      8.100      63
2998      1.      1.1809      8.863E-05      23.38      23.38      10.920      00      10.920      00
2999      1.      1.1809      8.863E-05      23.38      23.38      10.920      00      10.920      00

*****
AT FRACTIONAL (.7, .8, OR .9) KSUBC OF 52.000
KLIMIT=52.010
IN BLOCK 15      SEGMT 1 ( 1-TH TIME)      STEP 3139      CYCLE      0.0
*****

*****
AT FRACTIONAL (.7, .8, OR .9) KSUBC OF 58.500
KLIMIT=58.530
IN BLOCK 15      SEGMT 1 ( 1-TH TIME)      STEP 4197      CYCLE      0.0
*****

*****
KLIMIT=65.016 IS GREATER THAN KSUBC= 65.030
VALUES BEFORE INSTABILITY WERE
STEP 4780      OF BLOCK 15      SEGMT 1 ( 1-TH TIME)
C= 1.572758
*****

4940      1.      1.6422      3.434E-05      14.41      26.03      9.210      45      9.210      45
4947      1.      1.6432      9.940E-04      43.15      45.19      15.990      05      15.990      05
4948      1.      1.6433      5.781E-04      17.14      21.38      7.560      20      7.560      20
4949      1.      1.6433      7.693E-06      19.59      218.07      6.390      47      6.390      47
4950      1.      1.6433      2.990E-05      13.91      24.60      8.700      43      8.700      43
4951      1.      1.6464      1.551E-04      24.39      25.38      21.000      00      21.000      00
4952      1.      1.6466      1.551E-04      24.39      36.59      13.620      33      13.620      33
4953      1.      1.6468      7.655E-04      40.72      41.57      14.670      02      14.670      02
4954      1.      1.6476      2.397E-05      13.01      23.99      6.460      46      6.460      46
4955      1.      1.6477      8.294E-05      20.16      23.98      9.870      28      9.870      28
4956      1.      1.6480      3.325E-04      32.66      37.60      11.850      63      11.850      63
4957      1.      1.6514      3.335E-05      60.41      66.41      21.300      00      21.300      00
4958      1.      1.6514      1.944E-05      9.04      43.10      15.870      75      15.870      75

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F-B-2 AIR-TO-GROUND SPECTRUM, BASELINE

THE CRACK AT THE BEGINNING OF BLOCK										C = .683082		02/06/81	
STEP	CYCLES	C	CC/DN	DELTK	KMAX-C	SIGMAX	R	SIGMAX (EFF)	R (EFF)				
4960	1.	1.6514	3.293E-05	15.640	22.51	7.920	31	7.920	31				
4961	1.	1.6517	3.293E-05	29.848	22.41	12.810	18	12.810	18				
4962	1.	1.6518	3.293E-05	18.68	22.01	9.150	28	9.150	28				
4963	1.	1.6518	3.293E-05	19.739	22.08	9.090	61	9.090	61				
4964	1.	1.6518	3.293E-05	13.36	22.89	7.830	18	7.830	18				
4965	1.	1.6526	3.293E-05	37.61	22.80	16.110	13	16.110	13				
4966	1.	1.6537	3.293E-05	1.89	22.45	16.980	32	16.980	32				
4967	1.	1.6542	3.293E-05	4.55	22.54	12.840	01	12.840	01				
4968	1.	1.6546	3.293E-05	20.15	22.45	10.620	35	10.620	35				
4969	1.	1.6546	3.293E-05	35.42	22.84	12.620	48	12.620	48				
4970	1.	1.6554	3.293E-05	15.63	22.24	10.610	01	10.610	01				
4971	1.	1.6554	3.293E-05	41.31	22.60	14.310	00	14.310	00				
4972	1.	1.6559	3.293E-05	4.44	22.31	17.310	72	17.310	72				
4973	1.	1.6570	3.293E-05	13.44	22.67	13.200	37	13.200	37				
4974	1.	1.6571	3.293E-05	12.89	22.01	12.070	15	12.070	15				
4975	1.	1.6572	3.293E-05	19.59	22.13	7.410	40	7.410	40				
4976	1.	1.6573	3.293E-05	12.66	22.64	14.250	55	14.250	55				
4977	1.	1.6577	3.293E-05	17.45	22.64	16.090	49	16.090	49				
4978	1.	1.6580	3.293E-05	3.36	22.38	17.160	06	17.160	06				
4979	1.	1.6580	3.293E-05	8.96	22.90	11.610	28	11.610	28				
4980	1.	1.6595	3.293E-05	42.37	22.16	17.500	54	17.500	54				
4981	1.	1.6597	3.293E-05	19.08	22.08	13.680	14	13.680	14				
4982	1.	1.6598	3.293E-05	33.42	22.89	15.490	15	15.490	15				
4983	1.	1.6602	3.293E-05	8.82	22.77	10.050	44	10.050	44				
4984	1.	1.6604	3.293E-05	24.63	22.44	8.670	15	8.670	15				
4985	1.	1.6604	3.293E-05	38.52	22.72	14.430	04	14.430	04				
4986	1.	1.6611	3.293E-05	19.78	22.24	9.120	15	9.120	15				
4987	1.	1.6611	3.293E-05	24.96	22.42	6.760	35	6.760	35				
4988	1.	1.6613	3.293E-05	19.81	22.39	17.700	04	17.700	04				
4989	1.	1.6613	3.293E-05	12.70	22.61	15.850	15	15.850	15				
4990	1.	1.6613	3.293E-05	50.61	22.74	14.280	01	14.280	01				
4991	1.	1.6631	3.293E-05	16.06	22.87	17.020	57	17.020	57				
4992	1.	1.6631	3.293E-05	4.62	22.10	7.020	15	7.020	15				
4993	1.	1.6638	3.293E-05	8.68	22.68	1.663810	15	1.663810	15				
4994	1.	1.6638	3.293E-05	4.62	22.10	7.020	15	7.020	15				
4995	1.	1.6638	3.293E-05	8.68	22.68	1.663810	15	1.663810	15				
THE CRACK AT THE END OF BLOCK													

F-B-2 AIR-TO-GROUND SPECTRUM, BASELINE

THE CRACK AT THE BEGINNING OF BLOCK 16 C = 1.663813 02/06/81
 STEP CYCLES C DC/5W DELTCK KMAX-C SIGMAX R SIGMAX R
 (EFF) (EFF)

 ***** INSTABILITY OCCURRED BY APPLIED KMAX NOT KLIMIT *****
 ***** VALUES BEFORE 66.339 IS UNSTABLE AFTER 66.000 *****
 STEP 61 OF BLOCK 16 SEGMENT 1 (1-TH TIME) C= 1.687350

F-B-2 AIR-TO-GROUND SPECTRUM, BASELINE

02/06/81

ANALYSIS IS DONE WITHOUT LOAD INTERACTION

CRACK GROWTH SUMMARY TABLE FOR EVERY 1 BLOCKS

INITIAL CRACK LENGTH WAS C= .1450

C	.1544	.1651	.1774	.1915	.2080	.2274	.2507	.2792	.3148	.3606
C	.4218	.5083	.6415	.8831	1.6638					

CRITICAL CRACK IS: C=1.68731 BLOCK 16 STEP 61 CYCLE 0.

Appendix A

SUGGESTED PROCEDURES FOR DETERMINING CRACK-GROWTH-RATE PARAMETERS

To use the CRKGRO program for fatigue crack growth life predictions, a set of crack-growth-rate parameters should be determined for each material. The following paragraphs briefly describe a procedure for determining those parameters.

BASELINE CRACK-GROWTH-RATE CONSTANTS

Fatigue crack-growth-rate constants for the baseline (constant-amplitude) crack-growth-rate equations used in CRKGRO are the coefficient C, exponents n and m, in the following equation:

$$da/dN = C [(1-R)^m K_{max}]^n \quad \text{for } R \geq 0$$

plotting the dependent variable da/dN against the independent variable $(1-R)^m K_{max}$ on a double logarithmic scale, the preceding equation represents a straight line; i.e.,

$$\ln (da/dN) = \ln C + n \ln [(1-R)^m K_{max}]$$

where n is the tangent of the angle of inclination and $\ln C$ is the distance of intersection with the $\ln(da/dN)$ axis from the origin.

The procedures to determine the coefficient C and exponents n and m of the preceding baseline crack-growth-rate equation for a specific material are as follows:

1. Perform constant-amplitude fatigue crack growth test per ASTM standard E-647 or equivalent specification. It is recommended to perform the test with minimum four stress ratios $R=0, 0.3, 0.5$ and 0.7 .
2. Convert the crack size, a, versus the number of the elapsed cycles, N, to the fatigue crack growth rate, da/dN, using any of the two ASTM recommended data reduction techniques: the second method or the incremental polynomial method.
3. Plot the independent variable $[(1-R)^m K_{max}]$ versus the dependent variable, da/dN, on log-log coordinates with assigned m-values, either by hand or by a graphical routine such as PLOTATE, developed

by Chang et al (reference 11). It is recommended, in general, to input the following set of m-values:

$$m = 0.4, 0.5, 0.6, 0.7, 0.8, 0.9 \text{ and } 1.0$$

Note that if $m = 1$, the independent variable $(1-R)K_{\max} = \Delta K$.

4. Examine each da/dN versus $(1-R)^m K_{\max}$ plot. The m-value of a plot which shows the best stress ratio layer collapsing is the proper value to be used in the analysis. A straight line is then drawn either by eye-balling or computer, with least-square routine through all the collapsing data points. The intersection of this straight line with the $\ln(da/dN)$ axis gives the C-value, while the tangent of the angle of inclination of the straight line gives the value of n. A typical plot generated by PLOTATE for 2219-T851 aluminum is shown in figure A-1. It shows that $m = 0.6$ has the best collapsing on all the data points at various stress ratios ($R = 0.01, 0.2, 0.3, 0.5$ and 0.7). The corresponding C- and n-values are

$$C = 5.063 \times 10^{-10} \quad (\text{in ksi unit})$$

$$n = 3.83$$

LOAD INTERACTION MODEL PARAMETERS

Fatigue crack growth parameters to be used in the load interaction model built into CRKGRO are the overload shutoff ratio, R_{SO} , the acceleration index, q , and the threshold intensity factor range at $R = 0$, ΔK_{th0} .

The overload shutoff ratio, R_{SO} , and the threshold stress intensity factor, K_{th0} , are the parameters used in the generalized Willenborg retardation model for calculating the retardation coefficient, Φ , which is defined as:

$$\Phi = \frac{1 - \left(K_{\max_{th}} / K_{\max} \right)}{R_{SO} - 1}$$

where $K_{\max_{th}}$ is the threshold stress-intensity-factor value corresponding to the ΔK_{th} value in the following form:

$$K_{\max_{th}} = \Delta K_{th} / (1 - R) = (1 - A|R|) \Delta K_{th0} / (1 - R)$$

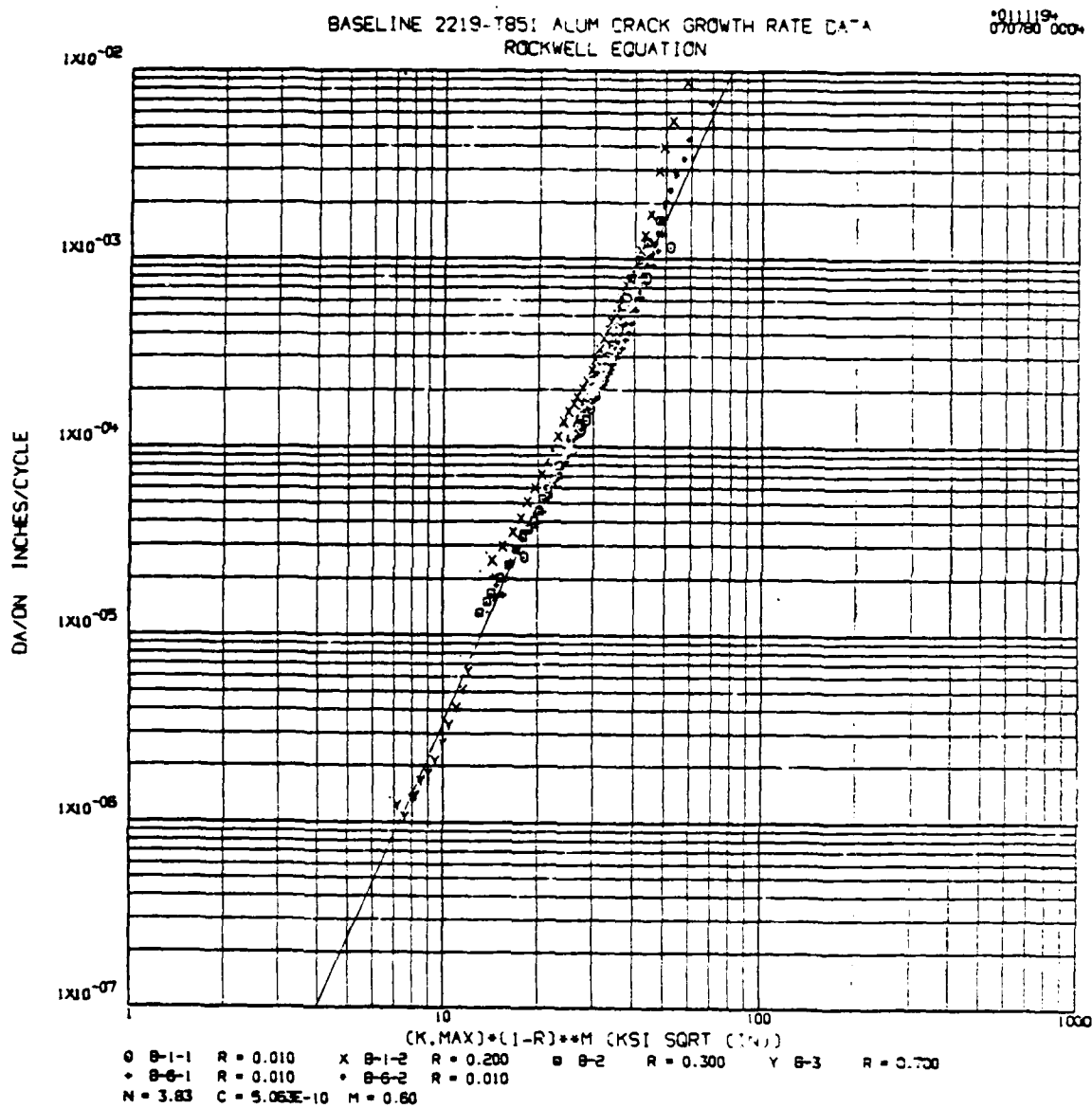


Figure A-1. Baseline 2219-T851 Aluminum Crack-Growth-Rate Data, M = 0.60

To determine the overload shutoff ratio, a series of single overload variable-amplitude cyclic tests are required. This is because, for a given material, the overload shutoff ratio is dependent upon the stress ratio and the magnitude of the compressive stresses. But, to be practical, it is recommended to test only the $R = 0$ condition to obtain the $R_{50}(0)$ value. This value is then to be calibrated using a typical spectrum which has similar characteristics to the one to be predicted.

The acceleration index, q , is the exponent in Chang's crack-growth-rate equation for negative stress ratio, which is expressed as:

$$da/dN = C [(1 + R^2)^q K_{\max}]^n, \quad R < 0$$

The value of q is determined using the following relationship:

$$q = [\ln(\gamma)/\ln(1 + R^2)]/n, \quad R < 0$$

where γ is the ratio of the crack growth rate at a specific negative stress ratio to its $R = 0$ counterpart obtained from test data. Hence, based on the preceding methodology for a specific negative stress ratio, there should be a specific q value. However, for spectrum loading application, it is not very practical to generate such q -values. The average q -value approach was adopted by CRKGRO. The average q -value for a material can be selected by correlation with the test data obtained from a spectrum loading test while the spectrum is similar to the one to be predicted.

OTHER PARAMETERS USED IN THE METHODOLOGY

There are several other parameters needed to be input into CRKGRO for crack growth predictions, including the cutoff values of the positive and negative stress ratios, R_{cut}^+ , and the critical values of the stress intensity factors under cyclic loadings, K_{cr} .

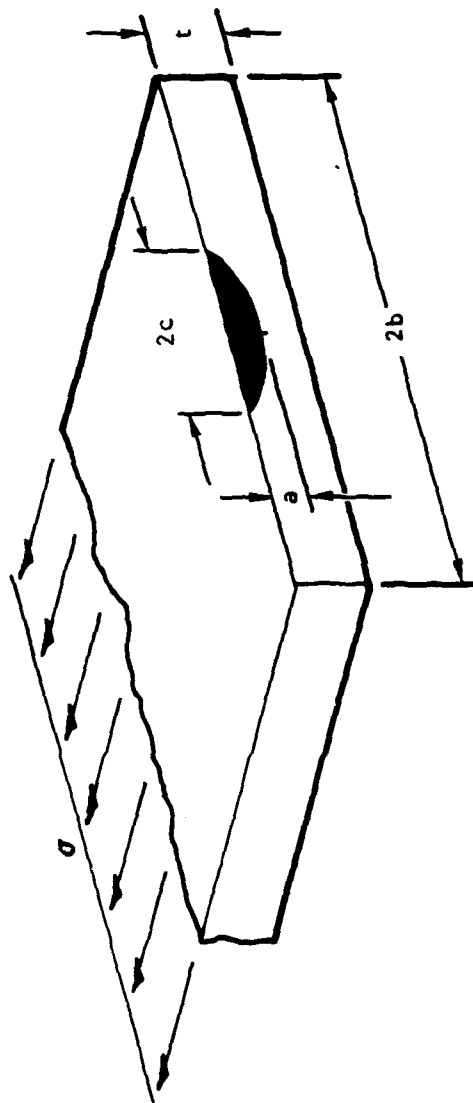
R_{cut}^+ is the cutoff value of the positive stress ratio, R^+ , above which the material is assumed to have no further stress ratio layering effect on the crack growth. R_{cut}^- is the cutoff value of the negative stress ratio, R^- , below which the material is assumed to have no further acceleration effect on the crack growth. These values are, in general, able to be determined from multiple stress ratios constant-amplitude tests. Yet, for the spectrum load application, because the effective stress ratio is used in the load interaction model, again, the calibrated value should be obtained using the spectrum test data.

There are two types of K_{cr} values: $K_{cr(a)}$ and $K_{cr(c)}$. $K_{cr(a)}$ is the critical value of the stress intensity factor under cyclic loading at the maximum depth point A of a PTC. In general, the value of $K_{cr(a)}$ is considered approximately equal to material plane-strain toughness. $K_{cr(c)}$ is the critical value of the stress intensity factor under cyclic loading at the maximum length point c of a PTC or TC. The value of $K_{cr(c)}$ is considered approximately equal to material plane-stress toughness.

Appendix B
CRKGRO STRESS INTENSITY FACTORS LIBRARY

Crack code: 1010

Shallow surface crack ($a/c \leq 1$)



$$K_{(a)} = \left\{ \left[1.13 - 0.09 \left(\frac{a}{c} \right) \right] + \left[\frac{0.89}{(0.2 + \frac{a}{c})} - 0.54 \left(\frac{a}{t} \right)^2 \right] + \left[0.5 - \frac{1}{(0.65 + \frac{a}{c})} + 14 \left(1 - \frac{a}{c} \right)^{24} \right] \left(\frac{a}{t} \right)^4 \right\} \sqrt{\sec \left(\frac{\pi c}{2b} \sqrt{\frac{a}{t}} \right)} \sigma \sqrt{\frac{\pi a}{Q}}$$

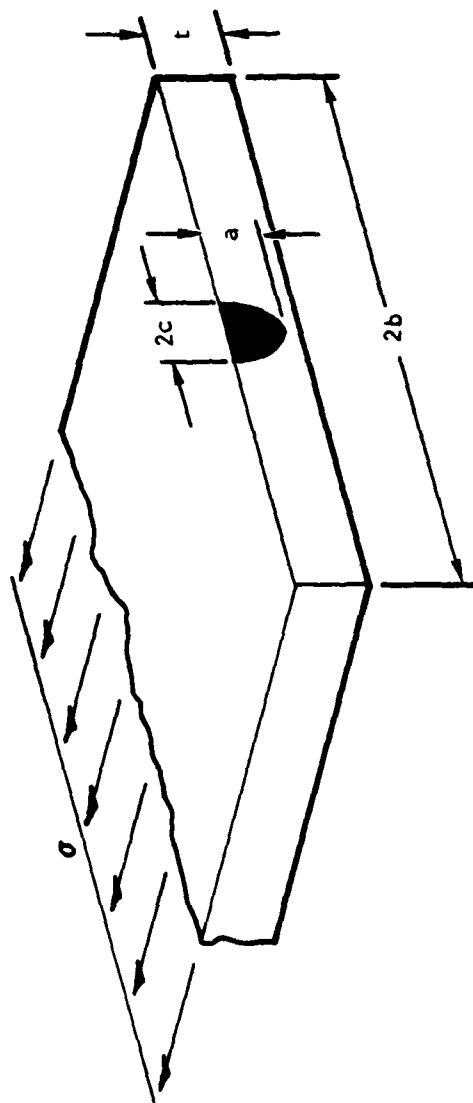
$$K_{(c)} = \left\{ \left[1.13 - 0.09 \left(\frac{a}{c} \right) \right] + \left[\frac{0.89}{(0.2 + \frac{a}{c})} - 0.54 \left(\frac{a}{t} \right)^2 \right] + \left[0.5 - \frac{1}{(0.65 + \frac{a}{c})} + 14 \left(1 - \frac{a}{c} \right)^{24} \right] \left(\frac{a}{t} \right)^4 \right\}$$

$$\left[1.07 + 0.24 \left(\frac{a}{t} \right)^2 \right] \left[0.97 \left(\frac{a}{c} \right)^2 + 0.03 \right]^{1/4} \left[\sqrt{\sec \left(\frac{\pi c}{2b} \sqrt{\frac{a}{t}} \right)} \sqrt{\frac{a}{c}} \right] \sigma \sqrt{\frac{\pi c}{Q}}$$

$$\text{where } Q = \left[1 + 1.464 \left(\frac{a}{c} \right)^{1.65} \right]$$

Crack code: 1010 (cont.)

Deep surface crack $\left(\frac{a}{c}\right) > 1$



$$K_{(a)} = \left\{ \left[\sqrt{\frac{c}{a}} \left(1 + 0.04 \frac{c}{a} \right) + 0.2 \left(\frac{c}{a} \right)^2 - 0.11 \left(\frac{c}{a} \right)^4 \left(\frac{a}{t} \right)^4 \right] \sqrt{\frac{c}{a}} \left[\sqrt{\sec \left(\frac{\pi c}{2b} \sqrt{\frac{a}{t}} \right)} \right] \right\} \sigma \sqrt{\frac{\pi a}{Q}}$$

$$K_{(c)} = \left\{ \left[\sqrt{\frac{c}{a}} \left(1 + 0.04 \frac{c}{a} \right) + 0.2 \left(\frac{c}{a} \right)^2 - 0.11 \left(\frac{c}{a} \right)^4 \left(\frac{a}{t} \right)^4 \right] \left[1.07 + 0.239 \left(\frac{c}{a} \right) \left(\frac{a}{t} \right)^2 \right] \left[0.03 \left(\frac{c}{a} \right)^2 + 0.97 \right]^{1/4} \right\} \sigma \sqrt{\frac{\pi a}{Q}}$$

$$\left[\sqrt{\sec \left(\frac{\pi c}{2b} \sqrt{\frac{a}{t}} \right)} \right] \sqrt{\frac{a}{c}} \left\{ \sigma \sqrt{\frac{\pi c}{Q}} \right\}$$

where $Q = 1 + 1.464 \left(\frac{c}{a} \right)^{1.65}$

CRKGRO Stress Intensity Factor Library

Crack Code: 1010

Surface Crack (one-dimension solution)

- Shallow Surface Crack ($a/2c \leq 0.5$)

$$K = \left\{ 1.13 - 0.1 (a/c) + \left[\sqrt{Q (c/a)} - 1.13 + 0.1 (a/c) \right] \left(\frac{a}{t} \right)^{\sqrt{\pi}} + \sqrt{Q (c/a)} \left(\sqrt{\frac{\pi}{4}} - 1 \right) \left(\frac{a}{t} \right)^{2\sqrt{\pi}} \right\}$$

$$\left[\sqrt{\sec \left(\frac{\pi c}{2b} \sqrt{\frac{a}{t}} \right)} \right] \sigma \sqrt{\frac{\pi a}{Q}}$$

where $Q = 1 + 1.464 (a/c)^{1.65}$

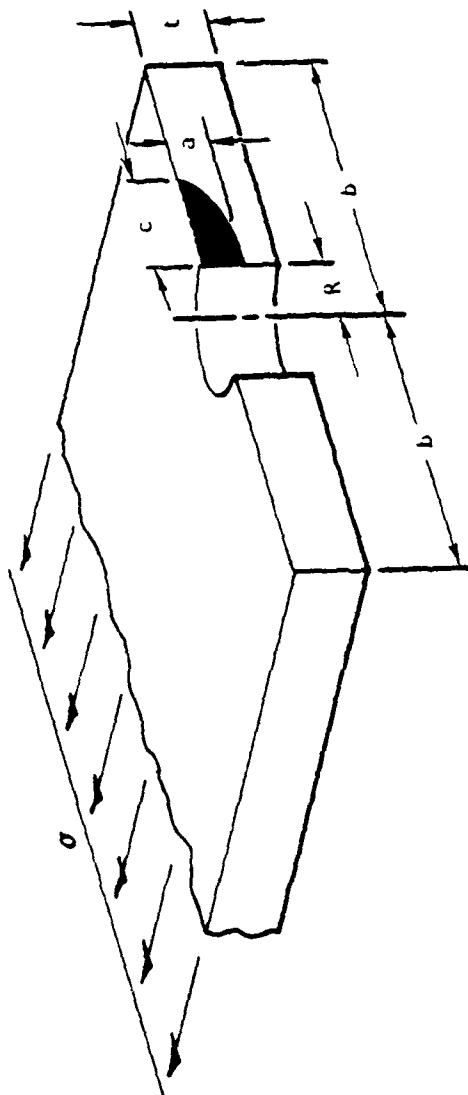
- Deep Surface Crack ($a/2c > 0.5$)

$$K = \left\{ \sqrt{\frac{c}{a}} (1 + 0.03 c/a) + \left[\sqrt{Q (c/a)} - \sqrt{c/a} (1 + 0.03 c/a) \right] \left(\frac{a}{t} \right)^{\sqrt{\pi}} + \sqrt{Q (c/a)} \left[\frac{c}{a} \left(\sqrt{\frac{\pi}{4}} - 1 \right) \right] \left(\frac{a}{t} \right)^{2\sqrt{\pi}} \right\} \left[\sqrt{\sec \left(\frac{\pi c}{2b} \sqrt{\frac{a}{t}} \right)} \right] \sigma \sqrt{\frac{\pi a}{Q}}$$

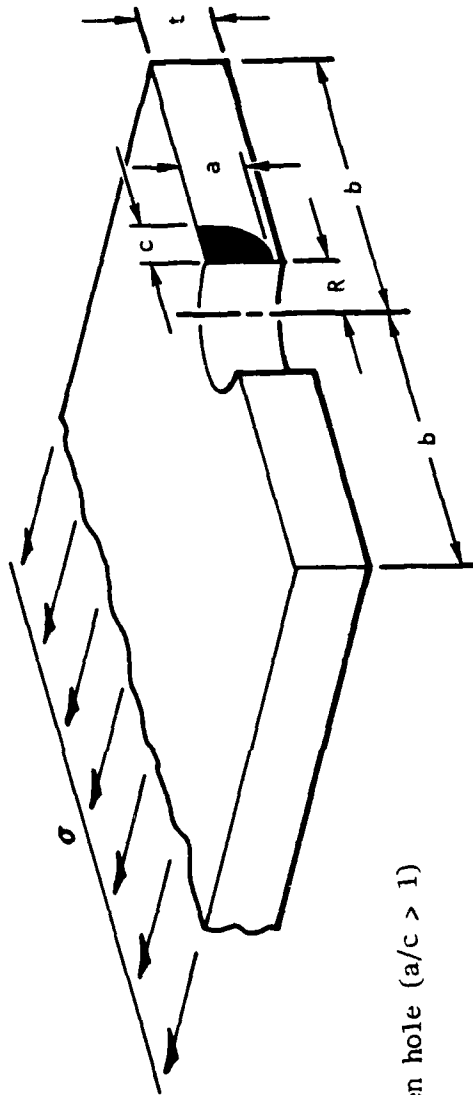
where $Q = 1 + 1.464 (c/a)^{1.65}$

Crack code: 1030

Single, shallow corner crack at open hole ($a/c \leq 1$)



$$K_{(a)} = \left[\left[1.13 - 0.09 \left(\frac{a}{c} \right) + \left(\frac{0.89}{0.2 + \frac{a}{c}} - 0.54 \right) \left(\frac{a}{c} \right)^2 + \left(0.5 - \frac{1}{0.65 + \frac{a}{c}} + 14 \left(1 - \frac{a}{c} \right)^{24} \right) \left(\frac{a}{c} \right)^4 \right] \left[0.9698 + 0.0302 \left(\frac{a}{c} \right) \right]^{1/4} \right. \\ \left. \left[\frac{1 - 0.15\lambda^2 + 3.46\lambda^3 - 4.47\lambda^4 + 3.52\lambda^5}{1 + 0.13\lambda^2} \right]^{1/4} \left[1.07 \left(1 + 0.04 \frac{a}{c} \right) \left(0.8 + 0.2 \left(\frac{a}{c} \right) \right)^{1/4} \right] \left[\sqrt{\sec \left(\frac{\pi R}{2b} \right) \sec \left(\frac{\pi(2R+c)}{2(2b-c)} \right) \sqrt{\frac{a}{t}}} \right] \left[\frac{8tR + \pi ac}{8tR + 2\pi c} \right] \sigma \sqrt{\frac{\pi a}{Q}} \right] \\ K_{(c)} = \left[\left[1.13 - 0.09 \left(\frac{a}{c} \right) + \left(\frac{0.89}{0.2 + \frac{a}{c}} - 0.54 \right) \left(\frac{a}{c} \right)^2 + \left(0.5 - \frac{1}{0.65 + \frac{a}{c}} + 14 \left(1 - \frac{a}{c} \right)^{24} \right) \left(\frac{a}{c} \right)^4 \right] \left[1.07 + 0.24 \left(\frac{a}{c} \right) \right]^{1/4} \right. \\ \left. \left[\frac{1 - 0.15\lambda^2 + 3.46\lambda^3 - 4.47\lambda^4 + 3.52\lambda^5}{1 + 0.13\lambda^2} \right]^{1/4} \left[\left(1 + 0.04 \frac{a}{c} \right) \left(0.8 + 0.2 \left(\frac{a}{c} \right) \right)^{1/4} \right] \left[0.9698 \left(\frac{a}{c} \right)^2 + 0.0302 \right]^{1/4} \right. \\ \left. \left[\sqrt{\sec \left(\frac{\pi R}{2b} \right) \sec \left(\frac{\pi(2R+c)}{2(2b-c)} \right) \sqrt{\frac{a}{t}}} \right] \left[\frac{8tR + \pi ac}{8tR + 2\pi c} \right] \sigma \sqrt{\frac{\pi c}{Q}} \right] \\ \text{where } \lambda^2 = \frac{1}{1 + 0.375 \frac{c}{R}}, \lambda = \frac{1}{1 + 0.989 \frac{c}{R}}, Q = 1 + 1.464 \left(\frac{a}{c} \right)^{1.65}$$



Crack code: 1030 (cont.)

Single, deep corner crack at open hole ($a/c > 1$)

$$K_{I(a)} = \left[\left[\sqrt{\frac{c}{a}} \left(1 + 0.04 \frac{c}{a} \right) + 0.2 \left(\frac{c}{a} \right)^2 \left(\frac{a}{t} \right)^4 - 0.11 \left(\frac{c}{a} \right)^4 \left(\frac{a}{t} \right)^2 \right] \left[\frac{1 - 0.15\lambda^2 + 3.46\lambda^2 - 4.47\lambda^3 + 3.52\lambda^4}{1 + 0.13\lambda^2} \right] \right]^{1/4}$$

$$\left[1.07 \left(1.13 - 0.09 \frac{c}{a} \right) \left(0.8 + 0.2 \left(\frac{a}{t} \right)^{1/4} \right) \left[\sqrt{\sec \left(\frac{\pi R}{2b} \right) \sec \left(\frac{\pi}{2} \left(\frac{2R}{2b} - c \right) \right) \sqrt{\frac{a}{t}}} \right] \left[\sqrt{\frac{8tR + \pi ac}{8tR + 2\pi ac}} \right] \right]^{1/4}$$

$$\left[0.9698 \left(\frac{c}{a} \right)^2 + 0.0302 \right]^{1/4} \left| \sigma \sqrt{\frac{\pi a}{Q}} \right|$$

$$K_{I(c)} = \left[\left[\sqrt{\frac{c}{a}} \left(1 + 0.04 \frac{c}{a} \right) + 0.2 \left(\frac{c}{a} \right)^2 \left(\frac{a}{t} \right)^4 - 0.11 \left(\frac{c}{a} \right)^4 \left(\frac{a}{t} \right)^2 \right] \left[1.07 + 0.24 \left(\frac{c}{a} \right)^2 \left(\frac{a}{t} \right)^2 \right] \left[0.9698 + 0.0302 \left(\frac{c}{a} \right)^2 \right]^{1/4} \right]$$

$$\left[\frac{1 - 0.15\lambda^2 + 3.46\lambda^2 - 4.47\lambda^3 + 3.52\lambda^4}{1 + 0.13\lambda^2} \right] \left[(1.13 - 0.09 \frac{c}{a}) \left(0.8 + 0.2 \left(\frac{a}{t} \right)^{1/4} \right) \right]$$

$$\left[\sqrt{\sec \left(\frac{\pi R}{2b} \right) \sec \left(\frac{\pi}{2} \left(\frac{2R}{2b} - c \right) \right) \sqrt{\frac{a}{t}}} \right] \left[\sqrt{\frac{8tR + \pi ac}{8tR + 2\pi ac}} \right] \left[\sqrt{\frac{\pi c}{Q}} \right] \sigma \sqrt{\frac{\pi c}{Q}}$$

where $\lambda' = \frac{1}{1 + 0.875 \frac{c}{R}}$, $\lambda = \frac{1}{1 + 0.989 \frac{c}{R}}$, $Q = 1 + 1.404 \left(\frac{c}{a} \right)^{1.65}$

Crack Code: 1030

Single corner crack at open hole (one-dimension solution)

- Shallow corner crack ($a/c \leq 1$)

$$K = \left\{ 1.13 - 0.09 \left(\frac{a}{c} \right) + \left(\frac{0.89}{0.2 + a/c} - 0.54 \right) \left(\frac{a}{t} \right)^2 + \left[0.5 - \frac{1}{0.65 + \frac{a}{c}} + 14 \left(1 - \frac{a}{c} \right)^{24} \right] \left(\frac{a}{t} \right)^4 \right\}$$

$$\sqrt{\sec \left[\frac{\pi}{2} \left(\frac{2R + c}{2b - c} \right) \sqrt{\frac{a}{t}} \right]} \sqrt{\sec \left(\frac{\pi}{2} \frac{2R}{2b} \right)} (0.707 - 0.18\lambda + 6.55\lambda^2 - 10.54\lambda^3 + 6.85\lambda^4) \sigma \sqrt{\frac{\pi a}{Q}}$$

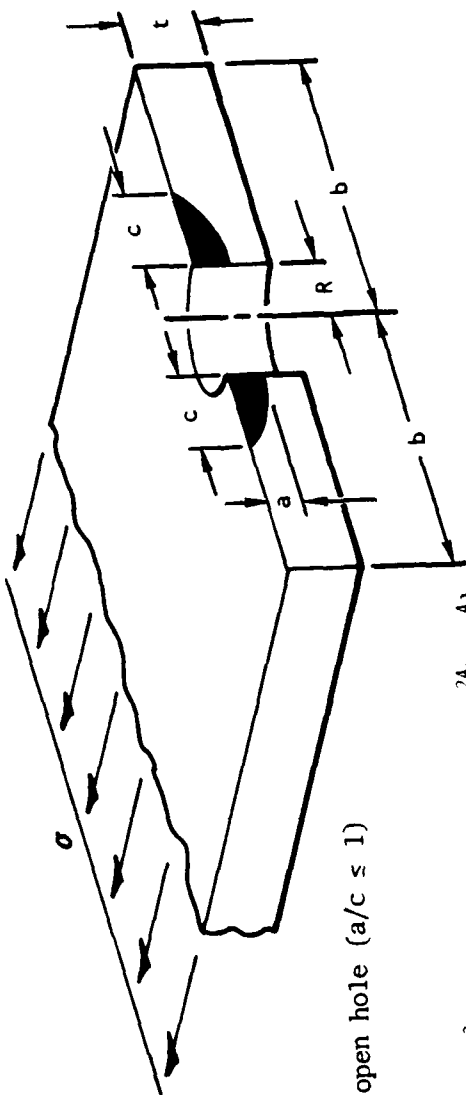
where $Q = 1 + 1.464 \left(\frac{a}{c} \right)^{1.65}$; $\lambda = \frac{1}{1 + c/R}$

- Deep corner crack ($a/c > 1$)

$$K = \left\{ \sqrt{\frac{c}{a}} (1 + 0.03 \frac{c}{a}) + \left[\sqrt{Q \frac{c}{a}} - \sqrt{\frac{c}{a}} \left(1 + \frac{0.03c}{a} \right) \right] \left(\frac{a}{t} \right)^{\sqrt{\pi}} + \sqrt{Q \frac{c}{a}} \left[\frac{c}{a} \left(\sqrt{\frac{\pi}{4}} - 1 \right) \right] \left(\frac{a}{t} \right)^{2\sqrt{\pi}} \right\}$$

$$\sqrt{\sec \left[\frac{\pi}{2} \left(\frac{2R + c}{2b - c} \right) \sqrt{\frac{a}{t}} \right]} \sqrt{\sec \left(\frac{\pi}{2} \frac{2R}{2b} \right)} (0.707 - 0.18\lambda + 6.55\lambda^2 - 10.54\lambda^3 + 6.85\lambda^4) \sigma \sqrt{\frac{\pi a}{Q}}$$

where $Q = 1 + 1.464 \left(\frac{c}{a} \right)^{1.65}$; $\lambda = \frac{1}{1 + c/R}$



Crack code: 1050

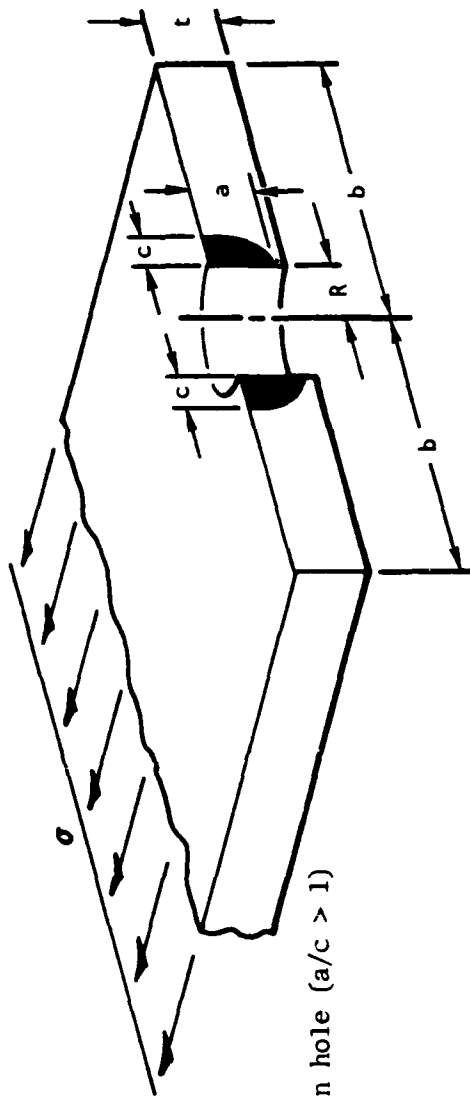
Double, shallow corner cracks at open hole ($a/c \leq 1$)

$$K_{(a)} = \left\{ \left[1.13 - 0.09 \left(\frac{a}{c} \right) + \left(\frac{0.89}{0.2 + \frac{a}{c}} - 0.54 \right) \left(\frac{a}{t} \right)^2 + \left(0.5 - \frac{1}{0.65 + \frac{a}{c}} + 14 \left(1 - \frac{a}{c} \right) \right) \left(\frac{a}{t} \right)^4 \right] \right. \\ \left. \left[\frac{1 - 0.15\lambda^2 + 3.46\lambda^2 - 4.47\lambda^3 + 3.52\lambda^4}{1 + 0.13\lambda^2} \right] \left[1.07 \left(1 + 0.04 \frac{a}{c} \right) \left(0.8 + 0.2 \left(\frac{a}{t} \right)^2 \right)^{1/4} \right] \left[0.9698 + 0.0302 \left(\frac{a}{t} \right)^2 \right]^{1/4} \right\}$$

$$K_{(c)} = \left\{ \left[\sec \left(\frac{\pi R}{2b} \right) \sec \left(\frac{\pi(R+c)}{2b} \sqrt{\frac{a}{t}} \right) \right] \left[\sigma \sqrt{\frac{\pi a}{Q}} \right] \right. \\ \left. \left[1.13 - 0.09 \left(\frac{a}{c} \right) + \left(\frac{0.89}{0.2 + \frac{a}{c}} - 0.54 \right) \left(\frac{a}{t} \right)^2 + \left(0.5 - \frac{1}{0.65 + \frac{a}{c}} + 14 \left(1 - \frac{a}{c} \right) \right) \left(\frac{a}{t} \right)^4 \right] \right. \\ \left. \left[1.07 + 0.24 \left(\frac{a}{t} \right)^2 \right] \left[\frac{1 - 0.15\lambda^2 + 3.46\lambda^2 - 4.47\lambda^3 + 3.52\lambda^4}{1 + 0.13\lambda^2} \right] \left[\left(1 + 0.04 \frac{a}{c} \right) \left(0.8 + 0.2 \left(\frac{a}{t} \right)^2 \right)^{1/4} \right] \right\}$$

$$\left[\sqrt{\sec \left(\frac{\pi R}{2b} \right) \sec \left(\frac{\pi(R+c)}{2b} \sqrt{\frac{a}{t}} \right)} \right] \left[0.9698 \left(\frac{a}{c} \right)^2 + 0.0302 \right]^{1/4} \left[\sqrt{\frac{a}{c}} \right] \left[\sigma \sqrt{\frac{\pi c}{Q}} \right]$$

where $\lambda = \frac{1}{1 + 0.375 \frac{c}{R}}$, $\lambda = \frac{1}{1 + 0.989 \frac{c}{R}}$, $Q = 1 + 1.464 \left(\frac{a}{c} \right)^{1.65}$



Crack code: 1050 (cont.)

Double deep corner cracks at open hole ($a/c > 1$)

$$K_{(a)} = \left\{ \left[\sqrt{\frac{c}{a}} \left(1 + 0.04 \frac{c}{a} \right) + 0.2 \left(\frac{c}{a} \right)^2 - 0.11 \left(\frac{c}{a} \right)^4 \right]^4 \left[\frac{1 - 0.15\lambda' + 3.46\lambda'^2 - 4.47\lambda'^3 + 3.52\lambda'^4}{1 + 0.13\lambda'^2} \right] \right\}^{1/4}$$

$$\left[1.07 \left(1.13 - 0.09 \frac{c}{a} \right) \left(0.8 + 0.2 \left(\frac{a}{t} \right)^{1/4} \right) \right] \left[\sqrt{\sec \left(\frac{\pi R}{2b} \right) \sec \left(\frac{\pi}{2} \frac{(R+c)}{b} \sqrt{\frac{a}{t}} \right)} \right]^{1/4} \left[0.9698 \left(\frac{c}{a} \right)^2 + 0.0302 \right]^{1/4} \sigma \sqrt{\frac{\pi a}{Q}}$$

$$K_{(c)} = \left\{ \left[\sqrt{\frac{c}{a}} \left(1 + 0.04 \frac{c}{a} \right) + 0.2 \left(\frac{c}{a} \right)^2 - 0.11 \left(\frac{c}{a} \right)^4 \right]^4 \left[1.07 + 0.24 \left(\frac{c}{a} \right) \left(\frac{a}{t} \right)^2 \right] \left[0.9698 + 0.0302 \left(\frac{c}{a} \right)^2 \right] \right\}^{1/4}$$

$$\left[\frac{1 - 0.15\lambda' + 3.46\lambda'^2 - 4.47\lambda'^3 + 3.52\lambda'^4}{1 + 0.13\lambda'^2} \right] \left[\left(1.13 - 0.09 \frac{c}{a} \right) \left(0.8 + 0.2 \left(\frac{a}{t} \right)^{1/4} \right) \right]$$

$$\left[\sqrt{\sec \left(\frac{\pi R}{2b} \right) \sec \left(\frac{\pi}{2} \frac{(R+c)}{b} \sqrt{\frac{a}{t}} \right)} \right] \sqrt{\frac{a}{c}} \sigma \sqrt{\frac{\pi c}{Q}}$$

where $\lambda' = \frac{1}{1 + 0.375 \frac{c}{R}}$, $\lambda = \frac{1}{1 + 0.989 \frac{c}{R}}$, $Q = 1 + 1.404 \left(\frac{c}{a} \right)^{1.65}$

Crack Code: 1050

Double corner cracks at open hole (one-dimension solution)

- Shallow corner crack ($a/c \leq 1$)

$$K = \left\{ 1.13 - 0.09 \left(\frac{a}{c} \right) + \left(\frac{0.89}{0.2 + a/c} - 0.54 \right) \left(\frac{a}{t} \right)^2 + \left[0.5 - \frac{1}{0.65 + \frac{a}{c}} + 14 \left(1 - \frac{a}{c} \right)^{24} \right] \left(\frac{a}{t} \right)^4 \right\}$$

$$\sqrt{\sec \left[\frac{\pi}{2} \frac{(R+c)}{2b} \right] \sqrt{\frac{a}{t}}} \sqrt{\sec \left(\frac{\pi}{2} \frac{2R}{2b} \right)} (1 - 0.15\lambda + 3.46\lambda^2 - 4.47\lambda^3 + 3.52\lambda^4) \sigma \sqrt{\frac{\pi a}{Q}}$$

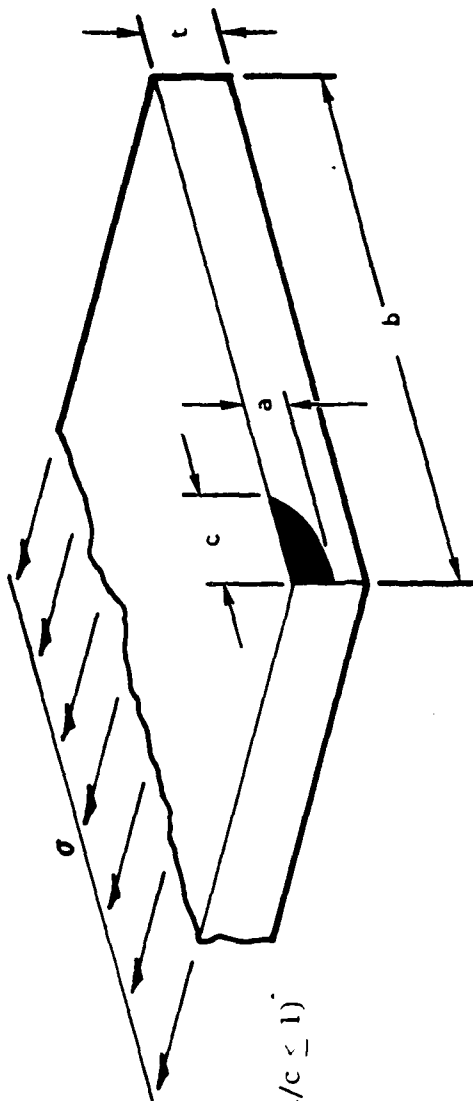
where $Q = 1 + 1.464 (a/c)^{1.65}$; $\lambda = \frac{1}{1 + c/R}$

- Deep corner crack ($a/c > 1$)

$$K = \left\{ \sqrt{\frac{c}{a}} (1 + 0.03 c/a) + \left[\sqrt{\frac{c}{a}} - \sqrt{\frac{c}{a}} \left(1 + \frac{0.03c}{a} \right) \right] \left(\frac{a}{t} \right)^{\sqrt{\pi}} + \sqrt{\frac{c}{a}} \left[\frac{c}{a} \left(\sqrt{\frac{\pi}{4}} - 1 \right) \right] \left(\frac{a}{t} \right)^{2\sqrt{\pi}} \right\}$$

$$\sqrt{\sec \left[\frac{\pi}{2} \frac{(R+c)}{2b} \right] \sqrt{\frac{a}{t}}} \sqrt{\sec \left(\frac{\pi}{2} \frac{2R}{2b} \right)} (1 - 0.15\lambda + 3.46\lambda^2 - 4.47\lambda^3 + 3.52\lambda^4) \sigma \sqrt{\frac{\pi a}{Q}}$$

where $Q = 1 + 1.464 (c/a)^{1.65}$; $\lambda = \frac{1}{1 + c/R}$



Crack Code: 1070

Single, shallow corner crack ($a/c \leq 1$)

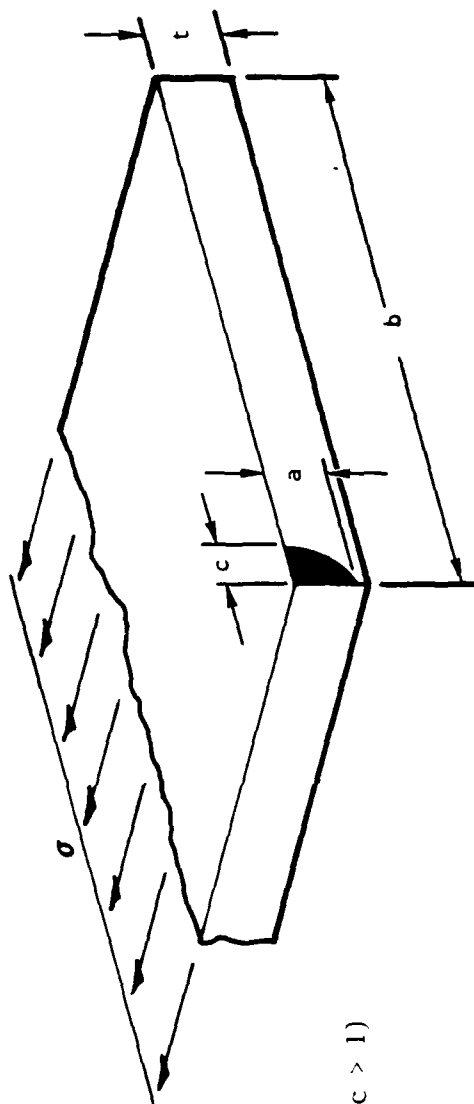
$$K_{(a)} = \left\{ \left[1.08 - 0.03 \left(\frac{a}{c} \right) + \left(\frac{1.06}{0.3 + \left(\frac{a}{c} \right)} - 0.44 \right) \left(\frac{a}{t} \right)^2 + \left(0.25 \left(\frac{a}{c} \right) + 14.8 \left(1 - \frac{a}{c} \right)^{15} - 0.5 \right) \left(\frac{a}{t} \right)^4 \right] \left[0.03 \left(\frac{a}{c} \right)^2 + 0.97 \right] \right\}^{1/4}$$

$$\left[1.045 + 0.085 \left(\frac{a}{t} \right)^2 \right] \left[\frac{1.12 - 0.231 (c/b) + 10.55 (c/b)^2 - 21.72 (c/b)^3 + 30.39 (c/b)^4}{1.12} \right] \left\{ \sigma \sqrt{\frac{\pi a}{Q}} \right\}$$

$$K_{(c)} = \left\{ \left[1.08 - 0.03 \left(\frac{a}{c} \right) + \left(\frac{1.06}{0.3 + \left(\frac{a}{c} \right)} - 0.44 \right) \left(\frac{a}{t} \right)^2 + \left(0.25 \left(\frac{a}{c} \right) + 14.8 \left(1 - \frac{a}{c} \right)^{15} - 0.5 \right) \left(\frac{a}{t} \right)^4 \right] \left[0.97 \left(\frac{a}{c} \right)^2 + 0.03 \right] \right\}^{1/4}$$

$$\left[1.045 + 0.226 \left(\frac{a}{t} \right)^2 \right] \left[\frac{1.12 - 0.231 (c/b) + 10.55 (c/b)^2 - 21.72 (c/b)^3 + 30.39 (c/b)^4}{1.12} \right] \left\{ \sigma \sqrt{\frac{\pi c}{Q}} \right\}$$

where $Q = 1 + 1.464 \left(\frac{a}{c} \right)^{1.65}$



Crack code: 1070 (cont.)

Single, deep corner crack ($a/c > 1$)

$$K_{(a)} = \left\| \sqrt{\frac{c}{a}} \left(1.08 - 0.03 \frac{c}{a} \right) + 0.375 \left(\frac{c}{a} \right)^2 \left(\frac{a}{t} \right)^2 - 0.25 \left(\frac{c}{a} \right)^2 \left(\frac{a}{t} \right)^4 \right\| \left\| 1.045 + 0.085 \left(\frac{c}{t} \right)^2 \right\| \left\| 0.970 \left(\frac{c}{a} \right)^2 + 0.03 \right\|^{1/4}$$

$$\left\| \frac{1.12 - 0.231 (c/b) + 10.55 (c/b)^2 - 21.72 (c/b)^3 + 30.39 (c/b)^4}{1.12} \right\| \sigma \sqrt{\frac{\pi a}{Q}}$$

$$K_{(a)} = \left\| \sqrt{\frac{c}{a}} \left(1.08 - 0.03 \frac{c}{a} \right) + 0.375 \left(\frac{c}{a} \right)^2 \left(\frac{a}{t} \right)^2 - 0.25 \left(\frac{c}{a} \right)^2 \left(\frac{a}{t} \right)^4 \right\| \left\| 1.045 + 0.226 \left(\frac{c}{t} \right)^2 \right\| \left\| 0.05 \left(\frac{c}{a} \right)^2 + 0.97 \right\|^{1/4} \sqrt{\frac{a}{c}}$$

$$\left\| \frac{1.12 - 0.231 (c/b) + 10.55 (c/b)^2 - 21.72 (c/b)^3 + 30.39 (c/b)^4}{1.12} \right\| \sigma \sqrt{\frac{\pi c}{Q}}$$

where $Q = 1 + 1.461 \left(\frac{c}{a} \right)^{1.65}$

Crack Code: 1070

Single edge corner crack (one-dimension solution)

- Shallow corner crack ($a/c \leq 1$)

$$K = \left[1.13 - \frac{0.09a}{c} + \left[\frac{0.89}{0.2 + (a/c)} - 0.54 \right] \left(\frac{a}{t} \right)^2 + \left[0.5 - \frac{1}{0.65 + (a/c)} + 14 (1 - a/c)^{24} \right] \left(\frac{a}{t} \right)^4 \right] \left[\frac{\sqrt{\frac{2b}{\pi c}} \tan \left(\frac{\pi c}{2b} \right)}{0.752 + 2.02 (c/b) + 0.37 \left(1 - \sin \left(\frac{\pi c}{2b} \right) \right)^3} \right] \sigma \sqrt{\frac{\pi a}{Q}}$$

where $Q = 1 + 1.464 (a/c)^{1.65}$

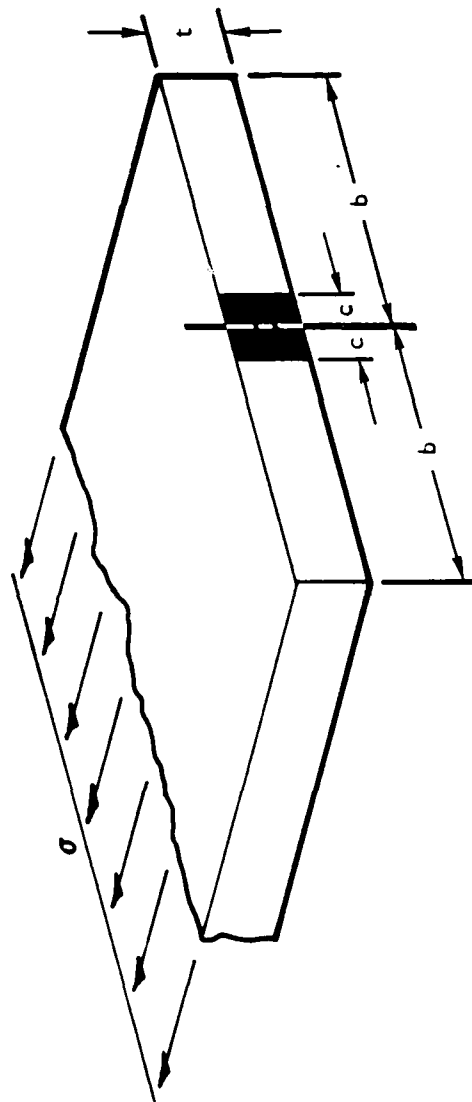
- Deep corner crack ($a/c > 1$)

$$K = \left\{ \sqrt{\frac{c}{a}} (1 + 0.03 c/a) + \left[\sqrt{\frac{c}{a}} - \sqrt{\frac{c}{a}} (1 + 0.03 c/a) \right] \left(\frac{a}{t} \right)^{\sqrt{\pi}} + \sqrt{\frac{c}{a}} \left[\frac{c}{a} \left(\sqrt{\frac{\pi}{4}} - 1 \right) \right] \left(\frac{a}{t} \right)^{2\sqrt{\pi}} \right\} \left[\frac{\sqrt{\frac{2b}{\pi c}} \tan \left(\frac{\pi c}{2b} \right)}{0.752 + 2.02 (c/b) + 0.37 \left(1 - \sin \left(\frac{\pi c}{2b} \right) \right)^3} \right] \sigma \sqrt{\frac{\pi a}{Q}}$$

where $Q = 1 + 1.464 (c/a)^{1.65}$

Crack code: 2010

Center through crack

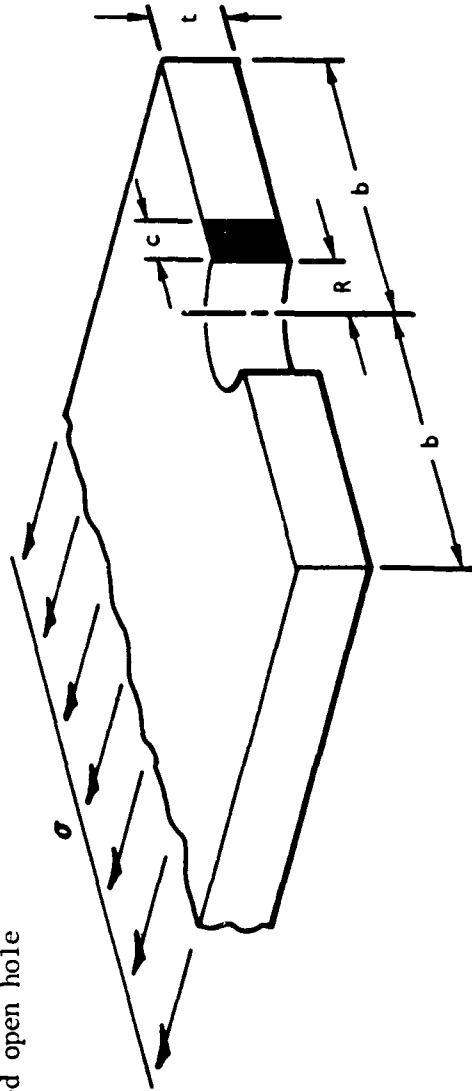


$$K = \left(\sqrt{\sec\left(\frac{\pi c}{2b}\right)} \right) \sigma \sqrt{\pi c}$$

*Reference: ASTM E647-78T, "Tentative Test Method for Constant Load Amplitude Fatigue Crack Growth Rate Above 10^{-8} m/cyc," 1978 Annual Book of ASTM Standard, Vol 10

Crack code: 2020

Single through crack at centered open hole



$$K = \left\{ (0.707 - 0.18\lambda + 6.55\lambda^2 - 10.54\lambda^3 + 6.85\lambda^4) \sqrt{\sec \left[\frac{\pi(2R+c)}{2(2b-c)} \right]} \sqrt{\sec \left(\frac{\pi}{2} \frac{2R}{2b} \right)} \right\} \sigma \sqrt{\pi c}$$

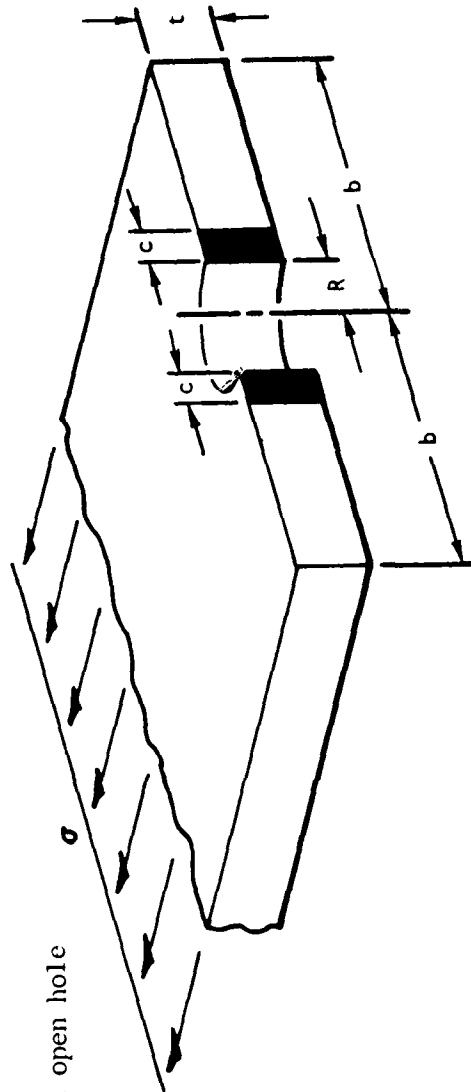
where

$$\lambda = \frac{1}{1 + \frac{c}{R}}$$

*Reference: Newman, J. C., "Predicting Failure of Specimens with Either Surface Cracks or Corner Cracks at Holes," NASA TN D-8244, June 1976, p 7

Crack code: 2030

Double through crack at centered open hole



$$K = \left\{ (1.0 - 0.15\lambda + 3.46\lambda^2 - 4.47\lambda^3 + 3.52\lambda^4) \sqrt{\sec \left[\frac{\pi}{2} \left(\frac{2R + 2c}{2b} \right) \right]} \sqrt{\sec \left(\frac{\pi}{2} \frac{2R}{2b} \right)} \right\} \sigma \sqrt{\pi c}$$

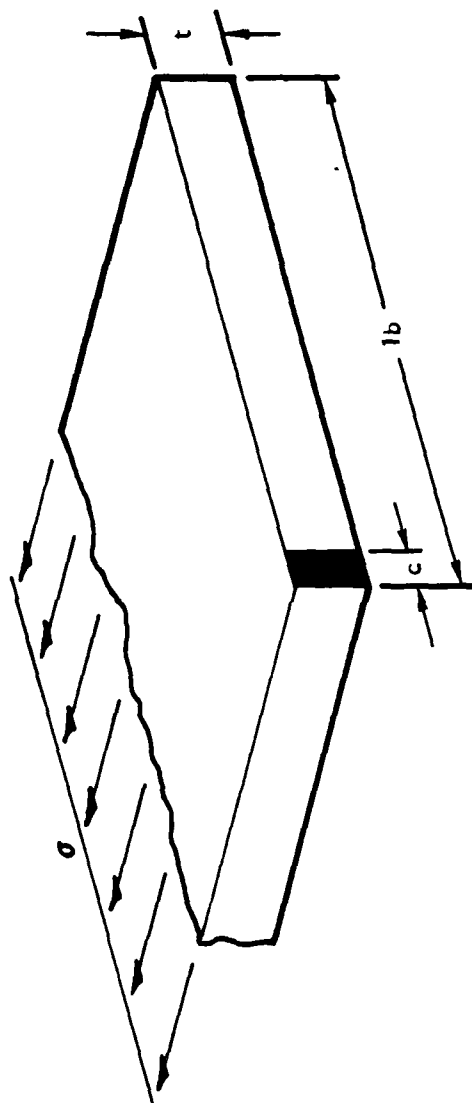
where

$$\lambda = \frac{1}{1 + \frac{c}{R}}$$

*Reference: Newman, J. C., "Predicting Failure of Specimens with Either Surface Cracks or Corner Cracks at Holes," NASA TN D 8244, June 1976, p 7

Crack code: 2040

Single edge through crack

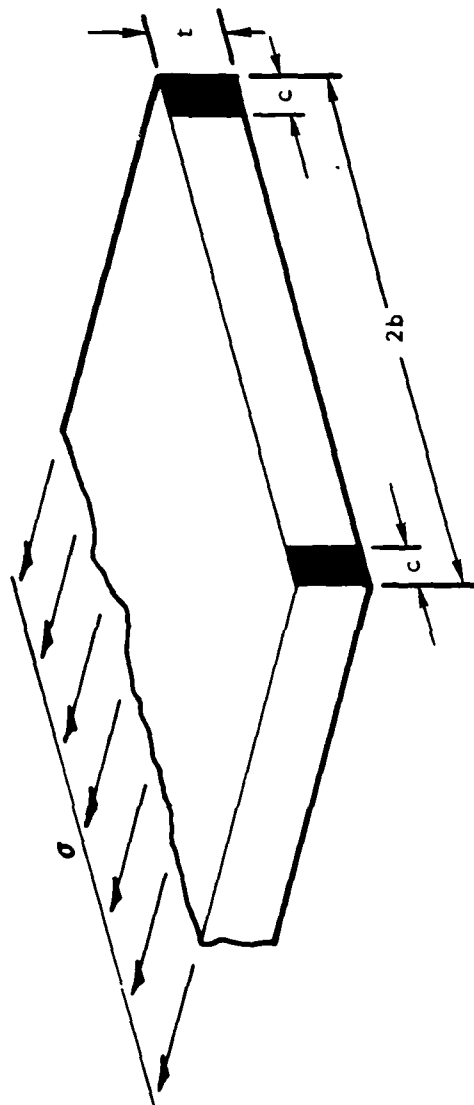


$$K = \left\{ \frac{0.752 + 2.02\left(\frac{c}{b}\right) + 0.37\left[1 - \sin\left(\frac{\pi c}{2b}\right)\right]^3}{\cos\left(\frac{\pi c}{2b}\right)} \right\} \sqrt{\frac{2b}{\pi c} \tan\left(\frac{\pi c}{2b}\right)} \sigma \sqrt{\pi c}$$

*Reference: Tada, H., Paris, P., and Irwin, I., The Stress Analysis of Cracks Handbook, Del Research Corp, 1973, pp 2-10

Crack code: 2050

Double edge through crack



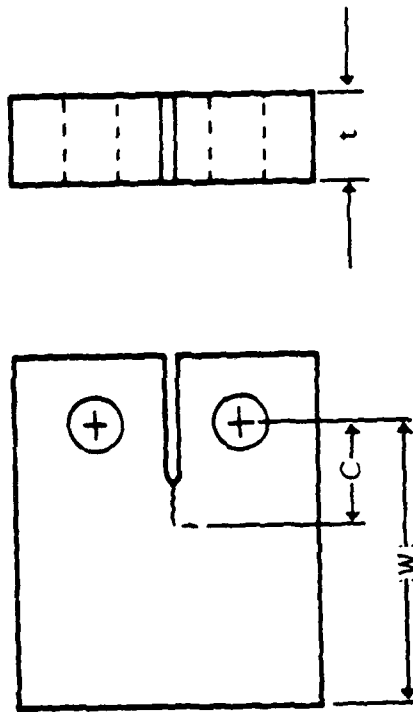
$$K = \left\{ \left(1 + 0.122 \cos^4 \left(\frac{\pi c}{2b} \right) \right) \sqrt{\frac{2b}{\pi c} \tan \frac{\pi c}{2b}} \right\} \sigma \sqrt{\pi c}$$

*Reference: Tada, H., Paris, P., and Irwin, G., The Stress Analysis of Cracks Handbook, Del Research Corp, 1973, pp 2.7

CRKGRO Stress Intensity Factor Library

Crack code: 2060

ASTM Compact Tension Specimen



$$K = \frac{P}{t\sqrt{w}} \frac{(2 + \alpha)}{(1 - \alpha)^{1.5}} (0.886 + 4.64\alpha - 13.32\alpha^2 + 14.72\alpha^3 - 5.6\alpha^4)$$

where $\alpha = \frac{C}{W}$

Appendix C

A TYPICAL FIGHTER AIR-TO-GROUND BASELINE MISSION
SPECTRUM TABLE

Appendix C

EXPERIMENTAL VERIFICATION PROGRAM, TEST GROUP I-A

FIGHTER BASELINE TEST

TEST F-B-2, AIR-TO-GROUND MISSION, DESIGN LIMIT STRESS (DLS) = 30 KSI

1	-10.0	39.1	29.6	41.5	4.2	39.1	7.8	48.9	37.1
2	8.4	37.8	18.4	28.8	17.8	49.5	13.8	26.8	42.9
3	11.4	74.1	20.3	24.5	1.5	21.0	17.3	39.9	50.8
4	2.1	71.5	11.3	24.5	5.5	33.1	17.9	55.4	51.4
5	3.6	18.9	7.0	2.9	11.7	48.6	3.1	17.7	44.1
6	30.6	42.4	25.3	44.3	2.9	31.2	4.9	28.8	29.7
7	18.8	28.7	14.4	44.2	16.4	45.2	3.0	51.6	33.5
8	1.0	21.7	6.7	50.5	12.3	47.3	-10.0	67.1	57.2
9	1.0	33.4	11.8	27.8	5.3	19.6	3.1	27.7	51.1
10	1.0	28.4	2.2	22.6	12.5	41.5	4.6	35.5	46.4
11	1.0	15.5	0.1	22.7	5.7	31.4	4.6	22.3	42.5
12	1.0	12.0	0.0	42.2	-10.0	31.1	7.1	23.7	35.2
13	1.0	49.2	11.0	14.7	4.8	29.2	3.2	22.3	42.5
14	1.0	26.2	11.0	47.8	5.8	17.2	-1.2	23.3	42.5
15	2.0	40.3	6.5	33.6	8.5	49.9	21.0	43.3	45.5
16	1.0	33.5	-10.0	25.1	8.4	75.6	11.3	42.2	45.6
17	1.0	71.7	5.1	35.1	11.2	52.1	1.4	46.5	57.5
18	1.0	46.4	1.1	24.1	8.5	40.8	21.2	42.7	23.5
19	1.0	28.4	1.1	35.5	5.2	38.5	4.4	40.0	53.5
20	-1.0	19.3	7.0	35.6	5.2	31.1	4.0	32.8	51.1
21	1.0	36.8	11.1	33.7	11.0	40.1	9.9	29.8	51.1
22	-5.5	25.4	14.3	66.9	6.5	30.1	17.9	38.8	33.2
23	1.0	38.1	8.6	35.2	0.0	37.7	18.1	37.0	36.0
24	1.0	23.3	7.7	37.7	3.0	30.6	10.3	52.0	36.7
25	1.0	39.3	3.5	33.8	4.4	32.3	7.7	35.5	29.6
26	1.0	47.4	3.3	33.8	14.6	32.0	7.7	32.2	46.5
27	1.0	37.9	3.3	33.8	15.3	45.3	-10.0	32.2	35.5
28	1.0	75.6	3.3	33.3	10.8	27.1	14.8	48.9	35.1
29	1.0	57.7	1.0	33.3	22.8	42.3	25.3	54.4	44.4
30	-1.0	53.9	1.0	33.3	27.0	39.1	8.3	53.9	44.4
31	2.0	47.8	1.0	33.3	-10.0	70.0	15.8	33.3	50.0
32	1.0	41.4	3.3	33.3	13.9	30.7	15.9	33.3	50.9
33	1.0	28.4	1.0	22.5	2.2	58.8	1.8	35.6	30.2
34	1.0	48.7	-1.0	22.5	3.5	18.9	2.2	55.5	27.6
35	1.0	33.3	2.0	32.1	11.4	31.7	1.4	16.7	29.7
36	1.0	15.5	2.2	32.1	11.4	31.7	1.4	16.7	29.7
37	1.0	64.4	2.0	22.5	18.9	41.6	13.3	24.6	25.7
38	1.0	34.4	2.0	22.5	14.8	37.9	13.3	25.6	25.7
39	-1.0	46.6	2.0	33.3	3.2	33.0	13.3	25.6	25.7
40	1.0	59.4	2.0	34.4	17.5	30.2	13.3	46.6	45.8
41	1.0	36.5	1.0	55.3	12.0	24.8	5.9	22.1	55.8
42	1.0	42.5	6.6	47.2	24.6	47.9	6.2	25.5	55.8
43	1.0	20.0	6.6	47.2	18.9	63.4	1.1	15.5	48.6
44	1.0	68.2	7.7	46.6	15.9	43.4	12.6	20.0	48.6
45	1.0	33.3	1.0	45.3	18.7	44.8	3.4	34.0	17.8
46	1.0	33.3	1.0	45.3	4.6	40.8	-10.0	60.0	19.7
47	2.0	33.3	2.0	46.9	19.5	54.1	-1.2	37.7	33.3
48	2.0	38.4	2.0	46.9	1.7	54.1	5.0	28.2	33.3
49	1.0	12.0	1.0	22.5	2.4	30.0	1.5	27.7	43.9
50	1.0	19.2	1.0	22.5	-10.0	25.8	1.5	28.8	43.9
51	1.0	49.2	0.0	22.5	5.3	21.0	5.2	21.0	43.9
52	1.0	49.2	0.0	22.5	5.3	21.0	5.2	21.0	43.9
53	1.0	22.4	-1.0	43.5	15.0	35.7	1.1	32.7	43.9
54	1.0	22.4	14.0	43.5	10.2	37.7	7.9	32.7	43.9
55	1.0	51.4	4.4	43.5	15.2	34.6	7.7	54.4	43.9
56	1.0	51.4	4.4	43.5	15.2	34.6	7.7	54.4	43.9
57	1.0	51.4	4.4	43.5	15.2	34.6	7.7	54.4	43.9
58	1.0	51.4	4.4	43.5	15.2	34.6	7.7	54.4	43.9
59	1.0	51.4	4.4	43.5	15.2	34.6	7.7	54.4	43.9
60	1.0	51.4	4.4	43.5	15.2	34.6	7.7	54.4	43.9
61	1.0	51.4	4.4	43.5	15.2	34.6	7.7	54.4	43.9
62	1.0	51.4	4.4	43.5	15.2	34.6	7.7	54.4	43.9

★ of DLS

EXPERIMENTAL VERIFICATION PROGRAM, TEST GROUP I-A

FIGHTER BASELINE TEST (CONTINUED)

TEST F-B-2, AIR-TO-GROUND MISSION, DESIGN LIMIT STRESS (DLS) = 30 KSI

63	5.4	37.8	27.1	43.1	6.0	21.9	6.4	23.4	11.2	34.7
64	5.3	42.2	8.2	42.7	17.5	42.7	4.3	41.1	15.1	45.3
65	11.9	24.8	12.0	42.9	3.7	23.3	-10.0	45.0	15.4	42.3
66	2.2	40.2	14.0	34.1	3.2	52.3	4.0	24.4	11.9	48.5
67	3.8	34.7	23.2	38.9	9.0	23.3	10.1	25.0	7.4	21.0
68	1.1	31.6	2.9	16.9	1.4	26.4	10.0	32.0	4.4	35.0
69	7.1	33.5	2.0	43.0	-10.3	26.4	13.1	46.3	11.8	35.1
70	34.6	49.6	1.9	28.3	7.3	35.7	8.3	50.6	11.3	51.1
71	2.3	34.3	14.2	36.8	14.2	33.0	21.6	41.5	11.0	48.3
72	9.5	41.6	19.7	47.7	11.3	59.6	6.1	51.4	11.0	36.5
73	3.7	57.1	-10.0	30.4	11.7	41.0	8.3	23.2	11.7	24.9
74	1.1	45.3	3.4	22.4	.5	40.5	12.4	33.3	16.0	43.0
75	14.7	42.4	3.4	11.9	5.1	49.5	2.2	39.4	10.6	44.4
76	14.7	46.6	3.2	35.4	5.1	44.5	5.4	25.6	10.6	31.7
77	-10.3	20.5	8.0	44.4	22.5	34.1	16.6	36.9	12.0	73.9
78	10.7	25.1	-2.0	63.6	3.5	62.1	15.4	27.5	12.0	31.0
79	12.7	40.8	21.9	1.0	11.2	22.0	12.1	23.3	12.3	33.6
80	22.9	49.9	12.4	46.9	5.4	29.3	7.8	35.1	-1.0	26.7
81	22.0	49.3	1.8	41.5	5.0	46.0	1.6	43.3	10.6	45.7
82	22.0	47.8	12.0	26.2	-1.4	18.9	-2.3	31.1	10.4	38.6
83	22.0	47.8	12.0	26.2	-1.4	18.9	-2.3	31.1	10.4	38.6
84	12.5	34.9	18.4	52.3	9.1	45.5	-12.2	27.0	16.4	43.4
85	12.5	47.7	18.4	52.3	9.1	17.7	4.2	19.6	14.2	22.3
86	12.5	51.6	18.4	19.1	-1.0	23.3	6.4	24.1	13.3	50.7
87	12.3	46.0	11.1	30.0	-1.7	27.6	7.4	30.7	14.0	35.1
88	21.1	36.1	12.5	35.7	-10.0	22.0	4.3	25.2	14.0	23.3
89	10.2	45.1	20.0	38.0	15.3	20.3	5.0	53.0	11.1	44.7
90	12.5	38.3	20.0	35.1	4.8	50.4	2.2	26.0	11.1	43.7
91	29.8	41.6	-10.0	35.3	2.6	22.0	1.7	31.9	14.7	44.9
92	1.7	37.9	-10.0	34.8	2.0	29.9	5.1	46.6	14.3	14.5
93	1.5	16.9	22.0	45.5	10.0	20.0	5.5	17.7	5.4	39.0
94	22.9	57.9	8.6	25.2	6.9	34.3	3.3	27.6	5.5	47.0
95	11.3	27.7	8.4	22.9	18.5	44.4	8.6	73.1	7.4	21.2
96	-10.0	69.0	10.1	35.0	14.4	43.5	5.9	26.0	24.1	28.0
97	14.2	53.4	10.0	35.6	4.3	35.1	1.1	56.0	25.9	45.6
98	14.1	37.1	8.3	31.2	1.5	22.9	7.9	32.1	10.6	65.9
99	4.4	24.4	12.0	11.2	14.3	27.7	14.1	41.1	20.1	33.3
100	32.4	55.2	7.6	40.9	1.5	55.3	11.0	40.6	20.5	36.5
101	4.6	35.7	14.7	25.6	7.7	24.0	9.1	33.3	11.2	40.6
102	16.1	37.1	5.5	49.5	11.9	35.8	6.2	21.1	8.1	31.8
103	6.0	17.9	7.5	12.4	2.4	56.4	11.0	32.2	16.7	33.3
104	1.1	24.6	7.5	37.1	5.1	56.4	21.0	33.7	16.5	33.3
105	25.1	40.1	8.6	60.3	9.2	58.0	23.7	37.9	15.1	38.4
106	4.9	21.3	6.7	54.9	21.4	58.2	3.2	23.5	1.9	44.3
107	11.7	29.3	13.4	22.2	-10.0	44.2	1.4	29.8	2.0	41.4
108	12.6	30.5	15.8	24.9	7.8	40.7	27.2	35.7	2.0	42.0
109	12.6	39.5	7.9	32.5	7.4	40.2	6.3	27.7	1.1	45.1
110	12.9	36.0	16.0	47.7	11.1	30.0	5.0	45.9	1.8	28.9
111	1.4	28.9	10.0	3.4	3.0	70.0	2.2	45.6	1.0	11.0
112	3.3	26.4	12.4	14.3	3.1	44.5	2.2	35.1	12.0	32.0
113	2.8	26.3	12.3	17.3	5.7	44.5	2.2	44.0	11.1	49.0
114	3.3	56.5	15.8	10.5	5.0	42.6	1.1	30.2	12.0	33.2
115	1.0	20.9	10.0	7.0	14.6	19.9	13.9	43.7	12.0	42.3
116	6.1	29.7	10.3	33.7	14.4	41.2	21.0	56.4	1.1	42.2
117	2.7	45.4	3.3	48.0	6.0	26.1	19.3	29.5	1.5	17.5
118	1.5	38.4	11.0	28.7	6.7	28.7	1.7	24.6	-1.1	15.1
119	4.4	30.9	21.0	30.0	5.7	47.2	2.0	23.4	4.4	42.0
120	21.7	32.0	15.0	6.2	11.9	33.3	15.5	38.1	2.0	50.6
121	13.2	37.0	13.7	44.0	0.6	32.1	15.0	46.0	2.0	72.0
122	14.8	35.3	11.6	4.2	3.3	32.1	15.0	46.0	2.0	13.0
123	1.1	34.4	11.0	21.7	5.3	47.6	14.7	42.6	1.0	41.0
124	3.7	44.3	4.7	21.1	.8	47.3	5.6	21.0	1.0	25.4

*% of DLS

EXPERIMENTAL VERIFICATION PROGRAM, TEST GROUP I-A

FIGHTER BASELINE TEST (CONTINUED)

TEST F-B-2, AIR-TO-GROUND MISSION, DESIGN LIMIT STRESS (DLS) = 30 KSI

125	2.6	24.2	1.1	55.5	27.7	21.5	0.1	46.8	0.1	37.1
126	2.5	32.7	1.0	27.1	-10.0	19.6	0.0	35.4	16.7	37.2
127	2.0	25.1	1.9	45.5	2.0	37.2	13.2	27.7	3.4	44.5
128	2.0	45.5	8.5	35.1	15.4	51.3	23.2	54.1	0.2	40.2
129	2.9	61.9	1.6	7.0	49.3	55.0	5.5	31.6	0.5	25.9
130	2.8	57.9	-10.2	40.6	30.1	49.7	9.7	40.6	17.9	31.0
131	2.8	47.9	10.2	24.1	2.1	13.9	1.2	17.1	3.5	52.1
132	2.8	53.2	-0.2	65.2	13.3	30.8	3.7	30.2	4.3	47.5
133	1.8	46.3	15.3	33.9	9.2	43.1	5.4	49.6	5.5	38.0
134	-10.0	31.4	1.2	24.1	13.4	42.0	23.1	66.0	-2.2	13.3
135	1.0	34.3	11.2	45.2	9.6	40.2	1.9	39.7	1.2	47.7
136	1.1	40.6	13.2	30.6	6.0	30.2	0.4	67.5	1.4	37.5
137	1.4	46.3	7.4	29.1	17.6	34.0	21.5	40.2	-1.1	28.1
138	1.5	55.8	27.1	46.0	2.9	31.0	3.0	22.0	3.6	63.9
139	1.1	50.7	11.4	60.9	2.7	46.1	5.7	22.0	3.3	46.6
140	1.3	25.5	-0.2	70.2	2.0	32.4	19.8	31.5	12.3	34.3
141	1.3	33.5	15.1	44.1	9.7	55.8	-10.0	40.0	4.6	25.1
142	1.3	45.3	10.4	35.9	9.3	32.7	6.0	64.0	15.7	47.0
143	1.3	37.0	8.6	42.4	6.3	45.4	16.5	30.2	15.8	58.0
144	1.4	49.5	11.5	74.8	8.5	34.8	11.9	43.3	5.2	71.6
145	2.4	30.1	3.6	28.8	-10.0	44.1	13.1	58.0	11.0	32.7
146	2.0	33.3	17.6	46.8	11.2	45.2	18.0	31.4	1.2	50.3
147	2.0	20.3	5.3	48.5	2.9	35.9	13.3	27.5	13.3	23.8
148	-10.2	20.2	3.6	24.5	12.3	28.6	13.0	29.5	14.1	36.1
149	0.7	49.9	-10.0	33.1	10.7	50.9	8.4	41.6	1.5	28.9
150	0.7	47.0	14.6	41.9	21.7	35.9	7.3	52.3	6.7	45.0
151	0.7	26.0	7.0	29.6	2.5	34.5	6.8	40.4	4.8	34.3
152	0.0	25.4	4.2	38.4	1.3	16.4	-1.4	15.8	4.4	29.2
153	-10.0	21.0	2.0	32.3	9.2	30.4	5.9	33.7	7.7	32.3
154	0.5	40.2	17.1	35.5	9.1	22.5	11.5	77.7	5.5	32.4
155	1.0	41.3	1.7	39.7	5.2	25.4	5.6	23.3	6.7	76.7
156	1.0	23.4	6.1	38.6	11.5	23.2	2.2	18.1	-1.1	35.0
157	1.4	48.3	35.1	63.4	4.2	28.4	-1.1	21.6	1.9	43.6
158	12.7	56.1	19.4	45.1	-2.3	60.0	10.8	25.4	1.0	45.8
159	1.3	25.7	12.2	32.0	8.9	14.4	5.4	29.0	0.0	41.3
160	1.6	24.3	10.4	37.9	0.0	25.7	-19.0	33.5	16.2	58.0
161	1.1	32.8	2.0	43.4	16.3	39.8	0.7	43.6	2.1	34.7
162	6.2	30.9	3.3	45.1	8.7	37.5	17.9	34.3	7.5	47.2
163	2.4	37.9	-3.1	32.4	14.9	60.1	28.6	68.6	14.3	27.8
164	2.6	39.5	3.9	53.3	-10.2	31.5	11.9	63.8	15.4	68.5
165	1.0	34.7	12.0	28.3	1.2	19.0	4.0	67.3	11.1	44.9
166	4.6	27.3	12.6	64.3	20.4	32.3	6.0	32.6	21.3	55.4
167	2.4	54.4	0.6	24.2	2.5	20.3	6.0	41.4	2.4	41.7
168	11.9	44.9	-10.0	24.6	14.3	34.5	17.0	35.1	14.4	62.1
169	2.3	43.3	8.3	34.4	9.5	71.0	2.0	36.8	9.9	26.7
170	1.7	36.4	16.4	35.2	1.0	38.0	24.6	37.2	0.0	20.5
171	1.7	27.4	15.5	35.2	14.5	38.9	3.0	44.4	2.6	55.0
172	-10.0	37.2	9.5	27.1	3.3	26.1	6.5	26.6	10.6	24.1
173	1.7	49.1	-1.5	11.4	16.2	33.0	9.9	38.4	5.7	25.5
174	1.3	59.9	7.9	20.0	0.0	16.7	4.3	33.0	1.2	23.2
175	0.8	14.2	3.7	36.0	1.2	33.7	29.8	42.0	-1.1	23.7
176	0.3	63.3	16.5	30.5	3.2	34.5	1.9	62.0	1.4	29.3
177	0.7	34.0	12.7	35.3	0.3	47.0	0.5	25.8	1.8	42.1
178	9.9	21.3	10.9	42.3	18.5	49.1	26.2	43.4	12.0	30.1
179	4.0	43.3	12.0	44.5	7.4	33.3	-10.0	36.2	0.5	15.6
180	0.0	40.9	0.6	28.6	3.4	17.0	0.1	52.5	-1.1	22.4
181	11.1	41.3	4.2	32.8	3.7	30.0	0.0	43.7	8.1	28.4
182	5.3	50.2	1.7	17.1	8.3	30.2	0.5	33.4	2.0	34.3
183	4.0	17.1	3.0	56.9	-10.0	35.3	6.8	73.0	16.2	46.3
184	7.4	34.0	0.4	69.3	1.6	35.0	2.0	35.6	1.1	34.4
185	1.0	34.4	2.4	26.3	4.7	33.0	14.4	40.0	0.7	37.2
186	17.0	36.6	6.7	58.9	21.8	59.5	1.8	43.1	0.4	43.4

★% of DLS

EXPERIMENTAL VERIFICATION PROGRAM, TEST GROUP I-A

FIGHTER BASELINE TEST (CONTINUED)

TEST F-B-2, AIR-TO-GROUND MISSION, DESIGN LIMIT STRESS (DLS) = 30 KSI

187	22.6	33.8	-19.0	26.5	9.4	40.2	2.1	56.5	2.2	43.3
188	22.5	22.5	10.7	21.3	4.8	70.5	25.5	49.3	2.1	22.5
189	5.2	57.0	7.0	29.0	6.6	45.1	1.4	69.6	1.7	43.3
190	6.3	37.7	27.3	43.4	11.5	25.1	5.5	29.1	11.5	5.0
191	-17.0	56.9	19.4	32.7	8.3	22.5	7.9	35.1	11.6	46.4
192	26.2	40.1	4.7	41.5	6.4	59.2	4.2	42.4	16.2	35.5
193	7.6	22.1	0.0	13.4	1.2	41.4	-2.5	16.1	16.8	43.6
194	11.2	36.0	1.6	73.6	12.0	45.5	11.3	54.4	-10.3	23.7
195	2.2	37.7	4.2	27.6	16.5	55.5	8.5	33.5	17.3	47.4
196	5.0	50.3	4.5	17.3	5.1	41.4	5.1	26.5	7.8	43.0
197	22.7	34.2	5.7	19.2	5.4	36.4	17.5	54.5	17.5	32.4
198	13.2	54.0	13.2	35.2	6.4	39.6	-10.0	49.6	10.2	15.3
199	16.2	42.3	16.2	39.6	13.0	37.2	4.5	40.2	16.1	40.4
200	21.3	44.3	2.6	41.1	12.0	50.3	10.8	26.8	16.1	40.1
201	15.1	38.1	4.2	36.7	2.5	34.5	16.4	26.5	16.2	51.6
202	1.0	38.4	8.3	29.3	-10.0	53.2	1.9	34.1	22.2	49.6
203	1.4	38.4	17.5	44.5	3.3	43.4	0.0	45.2	22.2	45.0
204	1.4	24.2	7.4	47.2	2.9	35.1	2.2	46.4	4.4	45.3
205	2.4	41.0	7.3	26.1	10.8	52.0	2.2	58.3	10.3	27.8
206	12.5	32.0	-10.0	27.4	10.6	56.5	10.5	26.2	10.3	35.5
207	17.7	39.4	-1.3	52.9	10.3	46.6	10.2	28.8	8.1	47.9
208	23.6	61.3	8.6	26.3	1.9	33.5	2.7	24.4	6.0	34.9
209	23.4	40.0	2.2	43.4	13.9	33.5	2.6	49.3	10.3	14.3
210	-10.0	26.5	1.2	45.6	6.5	43.0	1.9	14.7	14.7	17.3
211	1.3	15.1	3.4	49.9	5.0	39.1	14.1	24.4	-1.4	33.5
212	1.7	34.5	13.1	26.6	5.6	30.6	15.3	33.9	-1.4	33.7
213	4.6	55.9	4.7	57.7	-4.3	41.4	21.2	35.4	-10.0	37.5
214	4.9	32.3	3.4	47.1	1.7	37.8	3.7	52.7	14.8	45.4
215	14.7	32.2	2.5	42.3	2.6	42.8	7.1	44.2	4.4	40.1
216	2.7	41.7	2.2	34.6	19.6	32.6	7.8	35.2	4.2	49.3
217	2.7	50.0	2.9	33.8	4.8	38.1	-10.0	37.5	12.7	38.7
218	4.3	31.2	12.3	71.3	-1.9	33.4	31.4	41.6	11.1	51.2
219	4.8	35.3	1.6	30.4	1.7	32.8	14.2	41.6	14.8	51.2
220	16.3	43.1	4.4	32.3	1.2	32.5	16.1	32.5	10.1	42.6
221	12.7	34.3	3.8	34.0	-10.0	32.0	16.2	36.6	10.1	41.2
222	1.1	44.6	13.3	38.0	20.9	44.7	16.2	24.4	10.2	35.4
223	17.9	38.2	3.6	37.3	2.8	33.3	3.7	43.5	22.2	45.2
224	6.1	19.3	1.3	24.7	11.7	47.7	2.7	44.4	2.6	46.6
225	1.1	50.2	-10.0	36.6	21.2	44.4	10.1	37.4	4.4	26.7
226	27.7	52.7	2.1	38.4	8.6	33.9	18.9	32.4	2.9	38.9
227	1.7	47.8	1.3	17.3	1.8	31.0	16.5	35.0	10.7	22.5
228	12.6	62.7	3.3	28.5	2.3	31.5	20.2	46.8	6.0	22.6
229	-10.0	44.4	15.5	43.4	12.8	24.9	6.4	20.0	10.3	32.0
230	17.2	56.8	4.7	21.5	12.8	24.9	7.4	20.0	10.3	32.0
231	17.7	33.4	15.5	28.3	3.5	35.2	15.4	37.0	-1.4	41.5
232	1.2	34.8	10.6	23.7	4.5	35.4	10.1	63.4	-1.4	77.7
233	1.7	21.6	13.5	13.5	1.2	30.0	10.0	14.4	10.3	33.3
234	1.6	52.3	10.0	41.4	3.6	46.0	15.4	55.0	10.3	33.3
235	1.9	47.7	2.6	40.3	4.3	43.4	15.9	34.4	10.3	41.0
236	1.4	25.3	3.6	36.0	6.0	43.9	-10.0	31.4	10.3	41.0
237	1.0	37.2	15.3	33.7	14.0	49.6	10.1	31.1	10.3	41.0
238	1.6	20.6	4.1	42.2	2.6	49.3	11.7	42.1	10.3	41.0
239	1.0	21.5	4.3	22.0	7.5	43.1	11.5	42.1	10.3	41.0
240	1.0	36.8	2.6	20.3	-10.0	50.6	11.7	22.5	10.3	41.0
241	10.2	30.0	2.2	14.7	2.4	50.2	16.4	36.1	10.3	41.0
242	1.0	29.0	2.7	25.8	3.5	61.2	1.0	34.1	10.3	41.0
243	1.0	62.9	2.5	26.0	14.1	32.3	7.4	47.4	17.3	41.0
244	1.0	26.2	-10.0	25.2	5.5	38.7	3.7	53.3	10.3	41.0
245	1.0	39.1	1.1	25.9	0.2	43.8	3.7	41.1	10.3	41.0
246	1.0	18.4	6.2	54.9	2.1	11.2	11.0	26.5	10.3	41.0
247	1.0	27.2	7.8	15.2	12.2	16.5	12.7	24.0	10.3	41.0
248	-10.0	43.4	7.7	41.6	14.2	41.4	0.3	29.8	10.3	41.0

*% of DLS

EXPERIMENTAL VERIFICATION PROGRAM, TEST GROUP I-A

FIGHTER BASELINE TEST (CONTINUED)

TEST F-B-2, AIR-TO-GROUND MISSION, DESIGN LIMIT STRESS (DLS) = 30 KSI

249	16.9	61.9	2.4	27.7	8.5	31.3	15.2	29.2	5.2	35.6
250	17.0	64.7	23.7	42.9	11.2	27.7	5.4	24.5	4.0	24.1
251	5.5	31.9	15.3	47.4	14.7	33.6	12.4	29.1	-1.3	37.1
252	22.9	48.3	5.7	36.4	10.2	30.8	13.3	45.3	15.5	37.1
253	1.9	41.3	22.4	38.3	2.7	28.7	5.6	41.3	5.4	47.9
254	18.6	44.2	2.7	37.8	11.6	44.5	11.6	69.1	15.1	37.7
255	7.6	24.0	3.0	27.2	8.6	34.6	-10.0	31.8	7.6	32.5
256	17.9	33.4	11.6	35.1	5.8	31.5	8.0	23.1	11.2	28.4
257	5.9	50.4	11.3	42.6	1.7	27.1	5.1	30.1	2.8	31.5
258	7.5	50.6	2.1	26.9	12.3	46.7	12.9	36.5	4.3	46.3
259	13.0	40.2	7.4	33.0	-10.0	36.1	8.2	45.5	12.4	54.7
260	3.0	26.4	5.7	33.0	8.5	30.6	2.5	29.2	5.8	16.0
261	1.1	44.4	15.6	34.1	1.3	41.0	1.1	47.1	5.7	49.5
262	1.1	28.2	10.2	20.3	.1	48.6	8.7	30.0	5.4	49.7
263	10.9	44.5	-10.0	21.2	.5	34.7	.6	30.0	5.4	39.5
264	1.9	39.8	18.6	45.0	22.9	35.6	.5	41.7	5.5	21.2
265	1.0	29.2	1.0	31.1	3.1	36.9	2.3	38.0	2.3	41.2
266	17.7	51.3	16.4	48.0	.1	42.5	29.1	40.2	27.2	57.6
267	-1.0	26.2	4.8	32.8	21.4	38.7	2.4	25.5	7.7	52.2
268	15.5	40.3	2.7	30.0	5.6	33.1	14.5	41.5	1.1	41.8
269	21.2	35.4	2.4	33.3	12.8	33.1	1.1	62.2	1.0	39.5
270	22.4	63.0	16.0	54.2	4.5	39.5	32.6	43.0	-10.0	30.5
271	15.9	52.0	14.0	58.6	10.1	44.3	5.9	27.1	1.1	31.4
272	6.8	40.9	5.0	36.9	.5	32.2	1.8	43.3	7.8	23.4
273	12.4	34.1	8.4	40.9	7.3	31.6	3.8	18.4	5.5	24.5
274	13.4	69.4	7.5	29.6	1.3	32.0	-10.0	70.0	11.1	46.5
275	1.8	73.2	5.2	27.7	2.3	39.2	13.4	40.0	11.1	43.4
276	1.8	33.4	1.3	23.3	3.0	16.6	3.4	35.6	12.0	42.8
277	1.1	67.4	2.7	42.7	1.7	41.7	2.7	43.3	13.4	30.2
278	15.1	35.2	2.0	47.5	-10.0	42.8	28.2	40.0	13.4	45.2
279	14.9	53.2	2.1	52.7	33.7	35.0	23.1	34.4	4.0	17.1
280	4.4	20.1	3.7	50.3	19.4	36.6	5.7	18.8	6.7	55.4
281	17.2	31.3	6.2	33.9	8.4	44.6	17.3	44.4	14.0	42.2
282	10.2	43.6	-10.0	44.8	15.8	46.1	17.0	56.1	14.0	56.7
283	21.2	43.5	9.4	43.2	15.5	36.2	14.4	28.7	6.8	34.3
284	7.6	37.0	5.0	50.1	.6	37.5	9.5	41.0	2.8	55.6
285	17.9	29.4	6.3	32.3	8.6	27.4	6.2	42.0	7.3	33.4
286	-10.0	45.0	5.2	42.8	5.9	33.7	17.8	33.6	1.1	45.5
287	4.1	31.6	6.6	47.4	17.1	33.9	6.1	22.2	7.0	36.2
288	1.0	29.5	1.1	42.2	1.3	42.2	9.0	53.2	7.0	25.2
289	1.0	51.9	4.2	52.0	1.3	46.7	5.4	42.4	1.0	49.1
290	1.0	65.4	13.3	52.3	18.5	35.2	5.8	49.1	3.4	45.4
291	6.5	38.4	7.4	54.3	3.3	78.2	21.6	47.9	1.5	13.6
292	1.6	23.0	1.5	45.7	2.3	44.8	2.5	17.5	1.7	35.2
293	1.0	36.2	7.0	44.0	2.9	39.9	-10.0	61.7	14.0	36.2
294	7.0	41.4	16.4	27.9	16.5	32.1	17.2	27.8	4.2	43.2
295	5.1	23.3	5.4	32.3	8.1	30.7	.4	24.0	1.3	32.0
296	5.0	30.7	17.1	48.6	11.1	34.9	.2	42.5	2.3	37.6
297	7.5	24.5	1.9	41.4	-10.0	41.3	25.9	39.7	1.1	20.1
298	4.3	45.7	3.6	45.5	5.1	15.1	4.1	53.4	5.1	20.7
299	4.2	47.2	1.4	38.5	16.5	41.6	10.2	33.4	5.1	42.7
300	2.2	44.9	10.8	31.2	7.7	65.3	23.6	33.8	3.0	21.7
301	7.7	50.1	16.0	44.4	11.4	26.6	3.0	42.2	4.1	49.3
302	2.3	40.1	2.0	46.6	4.9	20.3	0.0	53.0	4.1	43.3
303	7.1	42.4	16.9	34.4	4.5	45.9	12.0	28.7	4.0	52.8
304	3.6	51.1	10.9	38.6	10.7	46.0	18.5	37.5	3.0	13.4
305	1.0	38.2	1.0	44.2	1.3	33.3	0.0	43.4	1.0	37.4
306	1.4	45.2	14.8	32.3	14.4	29.5	2.0	44.8	1.0	46.4
307	.2	43.3	6.1	47.8	8.9	21.6	4.1	24.8	4.0	32.4
308	.2	38.8	14.1	44.7	.4	41.0	13.3	32.3	-10.0	30.4
309	.3	23.5	12.3	30.8	2.8	47.2	1.0	28.8	7.7	27.1
310	6.1	45.1	12.1	27.4	.6	45.8	5.3	36.7	1.5	31.5

*% of DLS

EXPERIMENTAL VERIFICATION PROGRAM, TEST GROUP I-A
 FIGHTER BASELINE TEST (CONTINUED)
 TEST F-B-2, AIR-TO-GROUND MISSION, DESIGN LIMIT STRESS (DLS) = 30 KSI

311	11.7	43.3	14.6	29.0	6.9	31.3	1.1	35.9	15.4	51.9
312	12.3	37.2	14.5	21.4	16.6	47.3	-1.1	45.6	27.4	35.2
313	14.1	42.1	7.1	26.5	11.1	57.5	16.1	34.4	6.4	35.9
314	2.3	49.3	24.9	43.5	17.8	37.2	21.6	55.6	18.7	29.7
315	4.8	17.2	8.1	22.0	6.5	44.2	19.4	47.1	8.5	47.0
316	4.3	29.2	8.9	22.2	-10.0	38.8	18.2	46.8	8.2	44.0
317	17.3	51.7	1.1	22.5	26.2	34.5	3.2	37.2	8.2	22.5
318	1.0	41.0	1.4	16.4	4.4	40.3	5.7	28.2	3.3	35.0
319	11.5	27.3	10.5	24.2	6.1	48.4	2.3	53.6	5.5	52.4
320	11.3	52.5	-1.0	24.3	11.5	48.2	3.0	43.6	6.6	43.0
321	11.6	28.1	1.1	49.2	38.0	38.7	5.8	25.3	1.3	34.8
322	15.1	47.7	2.2	43.1	6.5	30.4	2.4	23.3	3.3	36.3
323	20.3	39.7	1.1	22.4	8.5	33.4	7.4	48.3	2.4	52.4
324	-10.0	36.7	2.2	51.1	5.1	33.6	2.2	43.2	16.5	52.7
325	14.8	14.8	1.1	55.6	5.6	42.4	11.8	32.1	16.2	52.0
326	2.3	26.3	1.8	33.5	14.4	42.7	18.9	30.4	14.4	54.9
327	1.6	54.8	2.4	50.0	14.2	45.2	-2.1	21.2	-1.0	23.1
328	1.9	18.2	10.4	22.3	9.1	33.4	0.9	26.7	11.7	28.8
329	1.7	43.3	1.4	39.6	1.6	35.6	10.4	51.6	11.2	53.0
330	2.9	39.1	1.7	33.2	2.4	33.3	-10.0	35.3	5.5	32.7
331	10.9	34.5	6.6	28.3	10.5	22.4	-1.3	19.9	9.7	19.8
332	4.3	24.2	4.5	33.4	16.3	29.4	10.0	45.9	2.1	39.9
333	1.4	42.5	4.7	36.7	-10.0	35.4	6.5	45.6	2.7	48.7
334	6.7	45.4	21.7	48.9	4.4	26.8	9.3	35.4	2.7	44.5
335	22.1	52.6	16.5	44.4	14.1	24.0	10.7	31.7	4.4	50.0
336	21.0	61.1	10.0	22.2	9.0	22.2	13.0	20.1	7.4	44.0
337	21.0	27.4	19.5	22.2	-5.1	22.2	-13.0	45.4	7.4	41.2
338	13.9	29.5	19.4	22.7	3.4	49.1	7.8	34.6	8.8	71.1
339	15.7	32.3	10.3	32.2	2.6	20.8	7.2	23.4	15.8	53.9
340	15.0	27.3	8.7	32.0	1.8	15.1	-2.2	25.2	1.2	44.9
341	26.8	33.5	4.6	33.5	8.7	26.3	3.6	21.2	11.4	47.4
342	2.5	40.5	4.1	43.4	2.4	40.5	7.7	34.2	-1.1	24.4
343	14.4	39.7	3.2	36.7	12.5	34.3	18.9	56.7	15.0	71.5
344	42.1	42.1	16.3	33.0	13.8	34.3	18.1	56.7	2.4	36.4
345	12.7	38.2	11.0	28.9	7.3	52.5	-10.0	29.8	14.9	23.6
346	19.9	42.0	6.2	39.3	18.9	32.2	18.4	19.7	8.3	33.4
347	14.4	46.9	4.6	42.3	23.9	44.4	18.1	40.9	15.1	29.8
348	16.9	42.6	1.6	33.3	-16.0	42.8	2.7	62.4	2.9	32.2
349	4.7	22.6	1.9	32.4	6.7	21.1	2.7	44.4	17.5	44.0
350	9.7	36.4	1.4	32.6	6.3	44.8	4.7	55.0	1.7	33.3
351	1.1	36.3	10.9	39.9	6.0	56.4	4.4	31.6	15.1	36.6
352	1.0	47.8	-1.0	35.7	9.9	22.0	4.4	49.6	1.5	22.0
353	2.2	26.1	1.4	47.7	4.8	35.3	17.1	22.0	1.5	44.1
354	10.0	24.4	11.3	47.3	0.0	41.2	18.6	30.0	7.5	33.3
355	1.1	22.4	20.6	39.9	3.5	37.4	11.1	46.1	7.7	44.0
356	1.1	36.4	1.1	48.8	13.8	47.4	11.0	32.7	-1.0	44.6
357	16.1	35.1	1.1	33.4	4.5	52.3	11.6	25.0	6.9	32.2
358	11.1	31.3	11.4	35.8	7.7	30.7	21.6	45.5	1.4	37.0
359	1.2	33.0	1.0	35.5	2.5	49.4	-13.3	33.3	1.1	44.1
360	27.9	45.0	6.1	33.3	3.1	34.4	8.5	21.0	15.4	44.1
361	2.9	20.2	1.1	39.3	-5.0	27.7	14.2	43.6	16.2	45.1

★ of DLS

EXPERIMENTAL VERIFICATION PROGRAM, TEST GROUP I-A

FIGHTER BASELINE TEST (CONTINUED)

TEST F-B-2, AIR-TO-GROUND MISSION, DESIGN LIMIT STRESS (DLS) = 30 KSI

373	1.4	41.0	-0.5	33.5	-10.0	14.1	2.1	48.5	27.1	45.2
374	7.3	39.1	6.0	43.7	17.2	13.1	6.6	26.4	16.2	28.2
375	11.4	44.5	19.6	80.0	9.1	22.7	16.1	25.6	16.3	39.2
376	3.0	59.2	8.1	42.1	0.0	70.9	12.1	25.5	16.3	34.2
377	1.0	68.2	-10.1	37.0	1.9	50.8	20.1	34.4	14.6	51.0
378	0.2	49.3	15.1	42.5	0.8	59.6	2.4	73.6	19.6	26.6
379	6.7	36.4	2.0	21.7	11.3	29.6	10.1	23.7	1.1	13.1
380	17.7	38.8	3.6	20.9	4.0	16.3	5.7	24.2	1.0	31.0
381	-10.0	40.7	-1.1	36.2	16.8	54.0	16.5	54.3	11.6	44.1
382	0.0	25.2	-13.0	38.7	27.5	50.7	17.6	33.4	1.1	41.3
383	20.0	70.3	0.0	36.5	26.7	45.6	11.0	38.7	6.0	24.5
384	1.0	33.6	11.7	29.8	9.3	19.9	3.2	26.6	-1.0	26.8
385	0.8	28.7	0.1	43.2	9.4	34.9	12.4	23.0	0.0	26.2
386	-11.5	40.9	7.6	41.2	6.5	30.1	0.9	32.3	11.0	42.0
387	9.0	30.6	3.7	60.4	5.3	17.1	2.1	27.7	0.0	48.8
388	12.4	48.7	12.7	41.4	6.5	41.4	-10.0	61.6	0.0	32.0
389	1.6	43.2	14.9	32.3	6.8	16.9	1.6	32.7	1.0	30.0
390	0.9	31.4	18.0	31.7	12.0	47.4	6.0	26.0	2.0	45.0
391	7.1	51.7	0.0	41.3	14.1	27.7	7.1	63.1	0.0	40.0
392	5.1	26.6	-11.4	65.2	-10.0	43.9	29.7	42.6	0.0	21.4
393	1.0	53.0	24.4	39.5	4.7	42.6	3.1	32.4	4.0	40.0
394	24.1	43.0	22.4	46.1	5.1	39.6	0.0	44.7	2.0	40.4
395	10.7	40.4	13.6	38.0	19.0	29.5	9.0	29.4	12.0	29.6
396	2.7	60.6	-10.0	48.2	15.5	49.4	-2.3	46.7	13.1	28.0
397	0.9	18.7	-2.5	20.5	4.4	18.3	5.2	25.2	1.0	52.4
398	0.1	22.0	6.4	22.6	8.7	42.7	23.4	61.5	1.0	15.1
399	0.0	42.1	1.6	32.2	19.1	34.8	3.8	37.8	0.0	36.0
400	-10.0	39.5	4.1	31.2	19.2	31.1	6.5	37.8	2.0	40.0
401	0.7	31.4	8.9	47.1	8.9	32.9	16.0	38.0	1.0	51.0
402	0.9	51.1	9.6	32.0	14.8	54.4	14.0	26.6	1.0	33.9
403	0.3	28.1	0.1	24.9	9.1	37.7	29.0	45.5	-1.0	43.0
404	2.3	49.7	3.2	21.3	6.2	34.9	2.6	43.2	1.1	33.2
405	16.4	38.1	11.2	43.1	4.9	50.4	3.5	57.4	1.7	42.4
406	2.1	43.3	20.5	37.8	13.8	47.0	1.1	41.7	1.0	13.7
407	1.2	25.7	5.5	19.4	5.2	17.4	-10.0	30.7	1.0	24.5
408	6.1	58.0	34.3	74.2	13.6	31.7	1.6	25.7	10.7	34.8
409	13.7	61.8	2.4	46.1	7.4	36.8	9.9	22.1	4.0	18.0
410	7.4	40.3	6.6	22.4	0.3	31.3	15.6	26.4	4.7	14.0
411	3.4	38.5	9.0	60.2	-10.0	74.6	14.9	52.0	5.6	42.0
412	1.0	25.6	0.8	32.7	12.2	56.3	9.7	16.0	5.0	53.0
413	2.2	38.7	27.8	33.7	11.1	44.7	9.7	40.5	14.4	43.6
414	1.3	29.5	5.7	58.8	32.4	52.5	-5.8	64.4	18.1	68.6
415	2.2	32.8	-10.0	26.5	0.1	29.2	12.0	42.4	1.0	30.0
416	0.7	17.9	6.1	30.3	5.0	16.4	5.7	24.5	10.1	37.9
417	12.1	70.0	7.2	25.1	4.9	52.6	0.1	14.1	3.0	32.0
418	5.7	26.6	13.4	41.1	4.3	50.2	16.0	45.5	3.0	47.0
419	0.0	56.5	4.9	76.3	4.5	46.2	1.1	25.8	13.0	38.7
420	0.5	48.5	1.7	36.8	4.4	23.3	4.5	27.2	4.1	28.3
421	6.7	23.4	-0.2	46.5	1.6	15.1	4.1	32.4	7.0	30.7
422	0.9	38.1	21.2	37.0	4.4	26.5	0.1	57.1	-1.0	32.7
423	4.5	25.8	4.0	26.2	3.9	38.2	3.2	19.3	0.0	45.0
424	2.0	34.7	1.6	34.2	5.1	33.2	3.2	17.5	4.5	73.2
425	11.1	34.0	1.2	30.1	7.6	43.1	-2.9	48.2	1.0	26.4
426	0.2	46.3	25.1	46.2	3.1	40.7	-10.0	42.6	2.0	52.6
427	0.9	27.3	2.1	33.1	0.1	23.6	15.0	47.4	12.0	36.7
428	7.8	29.3	1.1	24.3	11.1	58.5	11.0	47.6	7.0	23.0
429	12.9	27.2	1.4	32.1	7.5	28.9	13.7	51.5	18.0	41.4
430	1.7	70.4	-0.4	36.0	-10.0	54.5	26.9	38.4	10.0	51.3
431	16.7	32.4	14.3	43.7	16.5	17.4	8.8	42.6	2.0	11.1
432	6.6	58.6	7.3	24.1	4.1	39.4	1.1	28.7	2.0	15.4
433	0.4	20.7	18.8	41.8	0.7	40.5	5.0	17.4	2.0	69.9
434	5.0	34.6	-10.0	24.5	14.3	34.4	0.3	39.1	0.3	31.8

★ of DLS

EXPERIMENTAL VERIFICATION PROGRAM, TEST GROUP I-A

FIGHTER BASELINE TEST (CONTINUED)

TEST F-B-2, AIR-TO-GROUND MISSION, DESIGN LIMIT STRESS (DLS) = 30 KSI

435	-1.6	37.8	16.2	28.3	8.2	1.0	5.1	12.2	4.1
436	12.9	26.4	-0.2	24.6	-2.9	10.6	7.8	12.2	4.1
437	22.8	23.6	7.0	22.6	7.2	14.2	3.9	12.2	4.1
438	-10.0	68.8	7.1	26.5	10.8	23.1	3.9	12.2	4.1
439	9.7	70.9	5.3	25.2	3.2	15.2	2.4	12.2	4.1
440	16.1	42.4	2.2	20.0	4.5	8.2	9.6	17.2	4.1
441	.1	28.8	1.1	51.3	4.5	3.0	4.7	-1.9	4.1
442	7.4	40.2	5.8	77.5	17.5	1.6	24.2	1.7	4.1
443	.5	59.5	2.0	2.8	23.4	7.4	4.4	2.3	4.1
444	4.6	26.5	5.6	21.5	23.7	7.6	33.3	2.3	4.1
445	3.6	28.8	8.7	53.9	13.3	-10.0	25.8	11.6	4.1
446	3.3	28.5	5.0	2.6	21.0	3.4	5.3	11.6	4.1
447	14.9	28.8	1.2	34.4	16.2	3.9	5.5	12.6	4.1
448	1.3	37.7	1.1	41.1	-16.2	1.1	5.5	12.6	4.1
449	-5.1	27.0	13.3	41.2	-16.0	5.9	16.6	2.2	4.1
450	2.7	33.1	3.3	43.9	4.9	2.2	35.2	2.2	4.1
451	2.7	33.1	3.3	43.9	4.9	2.2	35.2	2.2	4.1
452	18.1	46.1	2.6	32.0	3.3	8.0	4.0	1.1	4.1
453	11.8	52.9	-1.0	36.9	1.3	8.4	5.0	1.4	4.1
454	11.8	28.4	3.3	44.1	1.3	7.7	22.7	3.6	4.1
455	10.7	31.1	1.0	38.5	16.4	3.9	3.8	2.7	4.1
456	-10.1	32.1	7.8	31.1	12.0	3.6	3.8	2.7	4.1
457	-10.0	36.9	7.7	33.1	12.0	9.6	3.2	2.7	4.1
458	28.2	40.2	2.0	66.3	2.2	11.5	56.5	1.4	4.1
459	2.4	18.2	-1.1	33.7	1.1	7.3	3.0	1.1	4.1
460	12.0	47.1	4.2	36.5	13.4	17.1	34.1	1.1	4.1
461	6.3	41.0	4.2	40.8	12.6	17.1	42.4	1.1	4.1
462	1.1	40.1	1.1	6.2	12.6	3.1	4.0	1.1	4.1
463	16.5	44.4	1.0	63.4	3.5	-10.0	36.0	1.1	4.1
464	16.5	44.4	1.0	63.4	3.5	-10.0	36.0	1.1	4.1
465	21.5	49.5	6.3	20.5	3.1	9.1	27.2	1.1	4.1
466	7.7	33.7	2.2	33.7	-10.0	11.2	2.7	1.1	4.1
467	11.7	33.7	1.1	33.7	14.8	1.1	51.7	1.1	4.1
468	11.7	33.7	1.1	33.7	14.8	1.1	62.7	1.1	4.1
469	11.7	33.7	1.1	33.7	14.8	1.1	62.7	1.1	4.1
470	11.7	33.7	1.1	33.7	14.8	1.1	62.7	1.1	4.1
471	11.7	33.7	1.1	33.7	14.8	1.1	62.7	1.1	4.1
472	11.7	33.7	1.1	33.7	14.8	1.1	62.7	1.1	4.1
473	21.2	39.2	2.3	35.3	14.9	17.4	41.7	1.1	4.1
474	2.2	61.8	-1.0	24.6	6.1	4.3	37.2	2.1	4.1
475	2.2	61.8	-1.0	24.6	6.1	4.3	37.2	2.1	4.1
476	-10.0	46.4	5.3	37.3	1.1	1.2	43.7	1.1	4.1
477	3.1	46.6	2.6	36.0	1.9	1.2	31.5	1.1	4.1
478	12.0	43.5	1.1	45.4	7.4	34.9	47.2	1.1	4.1
479	1.1	21.1	2.3	33.7	4.7	3.7	14.9	1.1	4.1
480	4.5	78.5	2.2	43.6	19.0	1.4	46.1	1.1	4.1
481	3.3	17.4	2.2	43.6	20.8	13.4	30.0	1.1	4.1
482	7.9	31.5	12.3	33.7	7.4	2.5	44.1	1.1	4.1
483	1.1	43.1	2.2	33.7	10.3	2.5	23.1	1.1	4.1
484	1.1	43.1	2.2	33.7	10.3	2.5	23.1	1.1	4.1
485	1.1	61.3	3.3	44.2	9.7	7.4	40.1	1.1	4.1
486	2.5	33.5	1.1	5.4	1.1	8.4	23.6	1.1	4.1
487	4.9	21.1	4.5	2.9	10.0	7.7	26.7	1.1	4.1
488	1.1	55.5	4.1	20.9	2.5	18.0	33.6	1.1	4.1
489	1.1	55.5	4.1	20.9	2.5	18.0	33.6	1.1	4.1
490	1.1	69.0	5.5	14.8	15.8	4.1	40.7	1.1	4.1
491	1.1	28.6	10.0	32.7	3.1	30.0	47.3	1.1	4.1
492	2.3	47.7	2.3	39.2	11.2	4.1	64.7	1.1	4.1
493	2.3	47.7	2.3	39.2	11.2	4.1	64.7	1.1	4.1
494	4.5	33.7	2.6	21.3	7.2	10.2	52.1	1.1	4.1
495	-10.0	58.2	4.5	1.4	2.8	1.6	34.0	1.1	4.1
496	22.4	41.2	1.4	26.4	9.4	9.3	37.7	1.1	4.1

*% of DLS

EXPERIMENTAL VERIFICATION PROGRAM, TEST GROUP I-A

FIGHTER BASELINE TEST (CONTINUED)

TEST F-B-2, AIR-TO-GROUND MISSION, DESIGN LIMIT STRESS (DLS) = 30 KSI

497	2.0	46.5	24.3	39.1	18.2	42.1	0.0	17.3	4.5	23.5
498	2.0	25.3	7.5	62.0	20.9	46.6	-1.7	41.1	-1.0	49.4
499	2.0	25.9	1.1	15.9	5.5	22.2	3.3	22.4	2.2	18.4
500	7.2	37.4	8.3	27.8	0.0	46.5	3.3	22.2	2.2	34.4
5001	1.0	19.2	8.8	27.7	8.2	23.1	9.1	25.4	9.5	20.1
5002	1.0	28.2	11.1	42.9	8.5	23.2	-10.0	32.7	12.8	40.6
5003	14.4	37.5	1.3	60.1	1.7	13.9	-1.3	35.1	2.1	41.5
5004	14.4	31.9	7.8	39.5	3.4	44.1	15.3	44.2	2.5	43.7
5005	1.0	25.5	7.7	23.8	4.5	46.5	12.3	28.7	4.4	28.0
5006	1.0	28.7	9.9	35.0	-10.0	43.5	22.3	41.2	1.7	39.1
5007	1.0	34.7	9.9	35.0	10.4	29.7	2.2	41.2	1.7	22.7
5008	1.0	25.1	-4.0	50.3	3.2	21.4	2.5	35.9	-1.9	37.7
5009	1.0	34.4	-1.1	18.3	18.3	40.6	18.1	39.7	1.4	23.2
5010	1.0	60.3	-10.0	34.2	11.7	28.4	8.8	71.6	12.5	43.7
5011	2.0	36.8	22.2	52.7	9.9	47.4	8.0	43.7	22.4	49.2
5012	12.7	61.3	22.2	56.0	3.4	35.8	17.7	37.2	2.2	20.6
5013	1.0	21.1	8.9	55.0	18.3	35.6	1.4	29.8	4.4	27.1
5014	-1.0	51.4	36.6	47.4	12.9	46.2	5.0	50.2	14.7	43.6
5015	15.4	39.6	19.8	45.4	-1.6	46.1	7.6	38.1	19.4	42.6
5016	1.0	38.3	18.8	32.4	3.5	24.5	3.4	47.3	31.2	42.4
5017	1.0	39.8	8.6	35.4	1.9	24.2	10.6	37.4	-1.0	29.8
5018	1.0	42.8	6.7	30.1	7.3	25.1	2.2	40.1	14.3	31.7
5019	1.0	45.4	7.8	43.1	3.8	32.5	2.2	52.8	14.3	24.9
5020	1.0	30.3	7.8	49.7	3.3	58.8	8.5	45.5	14.6	32.1
5021	1.0	76.9	8.5	25.3	14.7	45.1	-10.0	37.9	19.7	35.2
5022	1.0	39.5	6.0	36.1	8.0	48.1	19.6	67.7	7.7	25.5
5023	1.0	22.8	6.7	37.1	10.4	30.4	1.1	24.4	7.7	25.1
5024	1.0	32.7	8.7	66.1	11.0	37.4	11.7	29.6	4.4	23.3
5025	1.0	21.9	8.6	42.7	10.3	19.8	19.7	40.1	7.7	31.1
5026	1.0	43.9	1.1	17.8	6.7	19.8	1.6	46.6	3.3	30.5
5027	1.0	36.6	10.3	33.6	6.5	53.1	1.1	26.7	1.8	33.3
5028	1.0	36.9	12.4	34.1	10.4	46.6	17.2	32.8	1.8	46.3
5029	1.0	47.4	-10.0	40.3	20.5	32.8	7.3	29.6	1.8	44.5
5030	1.0	33.0	11.1	45.0	17.7	49.9	9.1	35.3	12.0	53.5
5031	1.0	61.3	13.6	38.9	22.8	77.7	1.1	66.2	12.0	24.5
5032	1.0	67.6	-1.2	56.9	-1.0	44.3	19.5	55.5	14.3	54.4
5033	1.0	45.9	8.9	49.0	5.5	62.3	19.8	34.6	1.8	51.5
5034	1.0	28.0	6.4	49.0	23.0	40.8	23.3	45.4	1.8	39.1
5035	2.0	52.0	6.4	44.0	1.4	32.0	8.0	42.4	-1.0	39.1
5036	2.0	40.5	3.3	27.9	16.2	28.3	6.5	27.2	-10.0	37.9
5037	2.0	31.1	1.5	25.8	2.2	35.3	18.6	42.6	1.1	44.1
5038	2.0	42.2	1.1	25.5	8.7	35.9	13.6	45.5	1.1	25.3
5039	1.0	26.9	16.8	44.8	20.3	34.3	10.6	29.4	1.8	47.2
5040	1.0	48.6	2.2	37.0	12.4	25.8	-10.0	60.4	1.7	34.0
5041	1.0	31.8	2.1	37.0	-1.4	41.7	10.3	27.7	1.0	37.6
5042	1.0	35.2	2.4	36.5	-1.4	33.3	11.4	23.8	1.1	23.0
5043	1.0	32.7	8.8	34.1	12.3	40.3	5.4	23.6	7.8	24.4
5044	1.0	32.5	1.1	14.1	-10.0	23.8	11.4	25.7	7.8	24.4
5045	1.0	32.1	1.7	20.1	9.7	45.7	11.3	41.4	1.1	40.1
5046	1.0	14.6	4.4	41.5	1.7	29.1	9.6	42.6	7.7	31.1
5047	1.0	38.7	9.9	24.8	9.6	23.6	12.4	23.4	1.8	33.0
5048	2.0	62.3	-1.0	50.0	21.2	47.0	11.9	41.6	1.4	53.0
5049	2.0	71.7	23.8	45.6	26.4	22.2	1.2	23.2	1.8	44.4
5050	2.0	23.4	1.1	41.6	28.4	28.8	4.9	26.4	1.8	17.4
5051	-1.0	23.9	1.6	41.6	7.8	28.0	2.7	43.2	1.8	28.8
5052	1.0	41.4	4.0	21.2	6.6	23.8	1.4	33.0	1.4	46.5
5053	1.0	20.0	4.6	37.7	8.5	24.0	5.9	34.0	-1.1	23.2
5054	1.0	20.6	5.7	29.6	9.2	24.9	11.6	34.0	-1.1	37.9
5055	1.0	24.1	4.4	24.1	5.2	16.2	2.4	29.0	-1.0	61.5
5056	1.0	24.3	4.9	17.8	3.3	36.8	1.1	27.7	1.8	48.5
5057	1.0	20.6	4.8	25.0	7.3	33.3	17.0	29.8	1.8	20.7

★% of DLS

EXPERIMENTAL VERIFICATION PROGRAM, TEST GROUP I-A

FIGHTER BASELINE TEST (CONTINUED)

TEST F-B-2, AIR-TO-GROUND MISSION, DESIGN LIMIT STRESS (DLS) = 30 KSI

559	4.4	35.5	4.4	51.3	5.2	70.0	-10.0	37.7	17.5	25.5
560	8.3	45.5	13.9	25.4	6.0	37.1	12.3	28.7	17.1	41.3
561	11.0	63.5	2.3	45.7	7.0	40.1	14.3	47.6	17.0	36.5
562	15.7	29.1	6.2	33.0	21.5	41.2	7.1	30.3	26.4	42.0
563	17.7	30.5	14.5	24.7	10.3	29.5	14.4	39.5	17.5	35.1
564	-4.1	35.5	-4.4	31.5	7.3	53.2	6.6	44.6	17.4	47.2
565	1.2	29.9	.9	44.6	16.8	36.2	2.1	34.6	17.4	46.3
566	1.5	23.6	.7	42.4	1.8	13.4	6.4	32.5	17.3	17.9
567	1.7	51.5	-10.0	25.7	0.0	12.5	6.3	15.7	17.7	37.1
568	1.7	19.0	2.1	21.4	1.0	57.5	6.3	22.2	17.3	38.2
569	1.5	31.1	1.3	35.2	3.6	26.5	6.5	47.4	17.3	22.5
570	1.8	26.5	8.7	22.4	3.6	28.3	9.7	44.4	17.3	55.7
571	-10.0	24.4	2.1	22.7	7.5	37.5	2.1	23.4	17.1	35.4
572	2.2	23.4	2.2	41.8	15.9	46.8	23.3	34.3	14.7	25.4
573	2.2	22.1	2.5	25.6	8.7	41.7	23.0	53.1	14.7	42.3
574	17.3	27.8	14.2	42.7	28.7	49.1	-3.4	26.8	-10.0	45.3
575	-1.0	42.8	-2.0	33.9	18.2	31.5	11.9	64.2	17.1	26.8
576	14.7	40.5	8.2	45.5	9.2	33.0	2.6	64.4	17.1	38.0
577	1.7	25.9	8.9	49.3	11.5	54.7	6.6	59.0	17.1	29.2
578	9.5	22.0	7.1	45.1	9.1	22.7	-10.0	37.0	17.1	35.6
579	10.5	24.5	10.5	42.5	22.3	35.6	-1.2	26.6	17.2	27.1
580	6.7	33.6	23.2	41.0	22.9	40.5	1.2	52.5	17.2	64.1
581	14.9	47.7	22.0	44.7	24.4	24.5	11.4	31.0	17.2	51.1
582	17.7	32.0	4.8	20.7	-10.0	44.0	7.7	41.0	17.2	41.5
583	2.1	37.4	6.3	31.2	27.8	78.1	2.8	51.2	17.2	55.2
584	11.4	28.5	6.8	31.7	1.1	36.9	6.4	20.4	17.2	34.0
585	8.6	26.5	1.0	12.2	3.2	50.9	5.0	45.0	17.2	35.3
586	1.6	51.4	-10.0	29.6	3.7	32.5	28.3	47.7	17.2	36.8
587	10.8	32.7	8.4	49.3	1.8	25.6	4.4	48.3	17.2	35.3
588	8.4	45.9	2.3	38.5	5.3	32.7	1.1	26.7	17.2	36.5
589	8.4	18.4	0.0	31.4	12.8	32.7	7.5	47.5	17.2	50.9
590	-10.0	45.9	-1.2	14.9	-6.4	51.0	15.1	29.0	17.2	49.3
591	7.4	28.9	1.4	22.4	2.7	43.0	17.3	45.5	17.2	52.4
592	-6.6	19.1	1.2	63.9	8.5	23.5	2.5	36.6	17.2	42.4
593	-6.5	46.1	3.3	20.1	9.8	60.4	2.5	38.3	17.2	44.5
594	8.7	41.7	7.5	33.5	2.5	32.2	3.0	30.5	17.2	37.7
595	4.2	15.7	2.2	15.0	21.3	37.4	12.3	26.4	17.4	28.7
596	1.6	52.1	4.0	15.6	4.8	38.0	6.7	30.0	17.4	49.0
597	17.0	36.9	3.9	27.7	10.4	37.3	-10.0	34.6	17.4	27.7
598	1.1	56.1	37.1	48.9	3.2	45.5	2.3	43.1	17.4	37.2
599	1.0	48.1	19.7	44.5	23.8	41.7	1.5	20.6	17.4	28.4
600	10.4	38.9	.1	22.6	7.9	49.8	16.9	27.0	17.4	36.4
601	12.0	45.2	20.7	22.9	-10.0	44.4	9.6	31.7	17.4	20.1
602	1.0	50.5	6.2	52.5	6.8	37.1	15.5	44.2	17.4	20.7
603	8.8	31.1	10.6	65.7	10.9	49.5	7.3	37.0	17.4	40.4
604	11.2	58.2	8.0	47.9	7.7	62.6	32.4	55.4	17.4	31.8
605	6.1	43.0	-19.0	27.3	5.5	30.2	15.4	32.7	17.4	32.5
606	1.9	22.3	3.0	36.2	15.7	37.6	15.6	47.2	17.4	36.9
607	4.4	34.9	1.7	14.4	9.1	40.8	12.6	26.1	17.4	35.1
608	5.7	25.1	5.5	49.6	20.8	40.9	8.9	40.6	17.4	59.2
609	-10.0	37.3	1.2	38.3	3.5	26.6	3.5	22.2	17.4	41.1
610	1.1	28.2	4.4	32.2	9.6	24.5	-3.5	31.7	17.4	22.5
611	1.9	41.2	8.7	35.9	6.3	32.7	2.4	24.4	17.4	27.7
612	-6.2	33.7	23.5	47.2	13.8	39.3	5.9	47.4	17.4	35.5
613	23.0	46.5	0.0	31.6	2.0	23.3	4.7	35.9	17.4	52.0
614	1.9	21.1	8.3	41.6	12.3	47.4	10.3	32.1	17.4	38.6
615	17.1	35.1	28.3	33.6	1.0	11.2	-14.7	41.1	17.4	50.2
616	16.0	40.3	1.9	19.6	4.8	60.7	-13.0	17.7	17.4	34.4
617	11.5	47.1	3.9	19.5	4.7	35.0	14.2	32.7	17.4	28.6
618	3.7	64.5	1.2	22.3	9.2	48.5	8.9	33.7	17.4	23.4
619	17.0	34.4	6.5	17.5	5.8	28.4	11.5	32.4	17.4	52.0
620	12.3	26.2	2.8	1.3	-10.0	12.1	1.1	33.6	17.4	42.1

★% of DLS

EXPERIMENTAL VERIFICATION PROGRAM, TEST GROUP I-A

FIGHTER BASELINE TEST (CONTINUED)

TEST F-B-2, AIR-TO-GROUND MISSION, DESIGN LIMIT STRESS (DLS) = 30 KSI

621	73.5	34.5	12.0	29.9	6.1	27.7	3.1	32.0	4.8	39.6
622	10.2	22.5	-1.4	22.4	6.7	47.0	14.1	34.9	3.2	36.7
623	1.0	21.0	2.6	26.0	8.4	33.2	2.5	27.0	4.4	46.7
624	76.3	55.1	-10.0	31.6	-3.4	36.8	18.3	36.3	17.3	42.9
625	1.8	24.7	0.3	70.3	11.4	32.2	10.3	33.4	10.4	39.1
626	18.7	36.4	14.3	40.1	14.0	34.7	-1.1	64.7	13.6	31.3
627	2.6	25.6	5.8	33.0	2.0	41.3	3.6	33.9	16.5	33.3
628	-10.0	19.0	1.6	42.4	21.4	53.9	0.0	74.1	1.6	43.3
629	1.1	31.7	2.1	54.3	18.3	43.0	29.6	44.2	1.1	43.9
630	25.5	53.7	1.3	42.3	14.6	31.9	20.6	34.5	1.1	33.4
631	10.4	47.9	1.3	12.7	1.1	37.0	11.6	46.5	-10.0	33.4
632	4.4	37.6	8.5	30.4	7.8	39.5	14.7	55.5	5.4	62.3
633	0.0	32.0	2.4	21.2	4.8	45.9	3.4	18.0	0.0	45.7
634	0.3	32.8	2.5	35.2	17.9	28.1	5.5	25.8	6.1	44.6
635	17.1	53.4	3.1	23.9	4.5	46.0	-10.0	53.1	1.8	57.3
636	3.6	15.1	4.3	17.3	-5.8	14.4	4.2	21.7	3.0	20.6
637	2.4	43.7	-0.6	34.1	9.1	31.3	6.4	28.4	4.6	28.9
638	15.5	48.1	8.6	20.4	5.1	45.0	6.2	42.4	2.0	59.7
639	2.7	28.3	1.1	21.6	-10.0	22.5	6.8	73.0	15.1	34.4
640	25.7	42.4	13.2	37.9	9.2	22.6	1.4	46.8	15.8	44.5
641	0.4	38.3	2.8	80.1	2.7	24.4	7.3	32.2	15.0	30.9
642	13.3	59.8	4.0	25.0	6.8	29.1	5.0	17.3	2.7	37.1
643	16.5	40.4	-10.0	26.3	3.9	30.2	1.3	56.1	2.8	27.6
644	0.8	35.7	4.4	63.3	4.3	40.7	24.6	45.4	2.3	41.5
645	0.6	77.1	13.2	48.3	-7.1	33.3	23.0	47.5	0.2	26.1
646	11.3	54.5	26.4	37.1	19.5	36.6	13.6	33.3	1.1	46.4
647	-10.0	54.3	12.7	34.4	15.8	38.9	11.8	44.7	9.1	28.6
648	8.1	33.3	14.2	35.6	16.9	65.3	14.5	67.5	12.2	56.5
649	0.9	64.0	14.2	47.5	7.4	28.0	2.2	32.2	2.3	41.4
650	12.9	46.7	1.4	24.1	8.4	52.6	0.6	25.5	-1.0	25.1
651	14.0	70.3	4.2	17.6	7.5	45.6	15.3	11.5	1.1	11.1
652	0.4	54.6	1.7	32.0	7.6	44.1	10.6	52.4	1.0	25.3
653	0.3	62.0	12.4	43.3	29.9	40.2	3.1	25.0	1.0	23.4
654	7.7	33.2	13.3	54.5	7.0	33.2	-10.0	38.6	1.7	20.7
655	4.1	31.7	20.7	55.2	3.0	45.8	19.8	44.5	21.9	46.5
656	6.4	33.0	6.3	43.2	12.9	42.0	4.2	41.2	6.3	40.7
657	4.3	42.0	11.3	29.6	12.4	22.3	11.5	30.2	1.8	46.7
658	2.5	33.0	10.2	21.9	-10.0	23.9	13.5	27.7	1.4	32.7
659	5.5	22.5	16.7	48.6	26.4	47.2	15.2	51.0	1.5	34.5
660	15.3	58.5	11.1	34.4	17.0	39.2	12.6	31.4	3.1	60.9
661	43.7	34.0	29.4	40.7	6.4	50.9	15.6	40.0	1.0	26.3
662	13.6	31.2	-13.0	47.2	25.7	50.9	37.1	48.6	16.0	26.4
663	4.4	37.1	8.8	26.3	16.0	45.1	17.1	52.1	7.6	25.1
664	6.5	47.6	16.9	52.6	1.6	35.8	15.0	64.0	7.4	22.4
665	-1.7	33.2	2.9	23.3	21.9	47.6	9.3	24.7	3.4	49.8
666	-10.0	50.0	0.0	25.5	7.9	20.6	7.0	31.3	5.5	22.3
667	-1.1	31.9	7.0	34.8	6.1	36.3	12.5	30.1	5.7	47.1
668	11.5	31.9	-1.0	41.1	23.6	34.1	16.5	50.0	-1.2	56.3
669	-1.4	44.1	10.0	20.4	12.2	44.0	-1.7	24.7	-1.1	20.9
670	2.3	45.7	9.3	21.3	9.6	33.1	6.8	20.7	2.7	31.0
671	11.7	47.2	-1.6	18.3	2.2	23.1	2.6	62.6	1.7	43.7
672	3.2	68.9	17.5	29.9	16.2	26.3	14.2	29.4	1.5	55.0
673	0.0	34.7	10.8	29.1	4.8	41.9	-1.3	30.4	-1.1	42.2
674	16.7	67.8	11.5	43.4	20.9	42.1	22.7	46.1	4.3	51.8
675	12.8	35.7	12.5	72.6	5.6	44.5	4.4	34.2	4.1	27.1
676	10.7	57.0	22.3	39.3	11.4	52.0	9.7	41.5	2.8	29.5
677	11.2	39.2	0.0	36.7	10.8	40.9	2.3	34.4	1.4	29.2
678	4.7	32.3	18.2	11.2	2.6	35.3	1.2	21.0	2.2	17.5
679	4.7	35.0	14.3	34.3	10.3	36.6	14.9	36.5	2.5	19.0
680	9.3	66.6	14.3	39.3	4.2	41.2	16.3	35.0	2.0	33.3
681	20.1	51.1	10.0	23.1	2.8	43.0	14.2	50.4	0.9	21.0
682	6.6	56.5	35.5	54.6	11.2	46.7	6.6	33.2	7.1	47.6

*% of DLS

EXPERIMENTAL VERIFICATION PROGRAM, TEST GROUP I-A

FIGHTER BASELINE TEST (CONTINUED)

TEST F-B-2, AIR-TO-GROUND MISSION, DESIGN LIMIT STRESS (DLS) = 30 KSI

683	15.9	37.0	6.5	29.1	10.2	33.3	1.3	45.2	15.8	33.3
684	18.5	46.8	24.5	45.6	10.6	39.0	1.4	35.1	22.3	36.4
685	-11.0	51.6	14.4	31.1	10.2	39.0	11.8	34.9	22.3	52.3
686	15.4	60.6	11.3	31.6	2.4	20.0	9.2	35.0	16.4	37.0
687	17.5	25.2	2.2	71.2	2.7	4.4	4.4	26.5	15.5	48.5
688	17.7	18.8	1.9	30.5	16.9	56.2	4.9	34.3	-17.0	74.7
689	18.9	36.3	21.1	73.0	1.7	44.6	2.4	33.4	10.1	51.2
690	18.6	26.7	6.7	37.1	6.6	49.4	5.5	44.4	6.9	24.7
691	18.4	47.7	12.0	37.2	15.1	41.5	3.2	35.5	14.6	27.1
692	18.5	21.2	2.3	79.3	15.4	46.0	-10.0	25.5	15.6	37.6
693	22.7	39.5	8.1	56.8	19.9	44.7	9.2	30.7	13.1	42.8
694	22.4	36.6	13.0	33.2	6.6	55.3	3.2	42.2	15.6	49.7
695	17.1	24.0	3.4	31.0	-4.2	61.5	3.5	43.0	15.6	55.2
696	17.3	57.0	1.4	45.6	-10.0	62.2	3.5	47.1	16.1	52.1
697	16.3	42.4	15.4	44.0	6.2	43.4	9.5	43.5	16.1	21.7
698	.5	26.2	15.3	27.5	1.3	43.1	4.9	25.2	13.2	34.3
699	17.8	39.5	5.1	41.7	8.7	28.0	10.6	45.0	11.3	49.0
700	17.3	17.3	-10.0	21.2	9.3	41.4	13.0	33.3	7.9	33.5
701	4.2	31.7	.4	31.1	3.6	39.2	14.3	33.4	7.9	35.2
702	17.4	28.7	3.5	32.2	2.1	35.5	10.4	34.1	5.1	39.7
703	17.4	49.1	1.1	43.7	11.2	33.2	1.4	43.4	4.4	29.9
704	-10.0	39.9	9.8	43.0	2.4	36.1	6.5	43.7	10.3	38.1
705	17.4	52.4	6.6	32.6	3.0	42.2	11.0	21.9	4.0	49.3
706	17.4	26.6	7.1	32.7	9.7	43.5	17.7	33.3	2.2	39.7
707	17.7	34.4	6.2	34.0	12.5	46.4	5.1	21.2	-10.7	48.1
708	18.3	50.4	13.5	35.7	10.0	29.0	13.4	36.2	11.1	41.0
709	18.0	40.0	20.0	35.4	26.3	27.7	17.1	27.0	3.6	30.7
710	18.5	37.5	11.7	29.0	.5	47.4	-3.6	57.0	3.2	49.4
711	18.4	28.5	11.6	35.2	12.2	37.7	-10.0	46.1	11.1	31.2
712	18.5	42.0	17.4	45.5	8.0	41.6	7.6	47.0	10.1	49.3
713	18.1	53.3	4.8	73.0	12.4	28.7	.2	20.5	6.6	49.9
714	2.1	36.6	4.1	36.1	6.8	19.1	2.4	36.7	2.2	38.2
715	4.0	42.0	5.7	32.0	-10.0	25.3	3.2	35.0	14.4	64.7
716	4.7	27.6	3.3	45.4	1.9	36.2	-1.5	36.0	15.5	32.1
717	.1	31.3	12.3	37.9	12.6	38.5	0.6	36.6	3.3	26.4
718	4.5	44.7	6.2	49.3	6.4	38.0	1.1	25.0	6.6	34.0
719	3.1	31.7	-10.0	34.3	16.3	36.5	17.9	47.0	1.7	40.3
720	2.8	43.2	13.3	32.2	11.1	26.1	5.5	70.1	8.8	31.0
721	18.0	41.4	6.7	42.0	.1	22.5	-1.7	43.6	15.0	49.5
722	18.7	47.9	8.1	41.4	7.6	20.4	14.7	31.6	15.0	30.2
723	-10.0	38.2	4.1	40.1	0.0	40.4	17.0	27.1	11.0	60.2
724	2.2	34.9	11.4	27.3	0.0	28.5	17.4	55.5	22.5	38.5
725	2.2	42.2	12.4	58.0	7.8	36.4	24.8	39.4	22.5	46.5
726	2.5	46.2	17.3	40.6	4.6	45.5	7.9	32.6	-13.0	53.2
727	14.0	29.4	14.0	24.1	13.8	24.4	11.1	41.5	17.4	43.6
728	6.5	30.5	14.4	45.5	16.5	49.2	15.7	66.6	17.4	40.0
729	7.3	43.2	8.3	28.7	16.9	43.8	14.2	46.5	15.7	45.1
730	2.0	39.6	6.4	25.0	1.3	60.7	-13.0	43.1	2.4	34.4
731	18.4	50.1	4.6	38.4	3.3	36.5	11.4	67.4	13.7	41.4
732	15.4	46.6	7.4	32.2	21.0	35.1	16.1	28.6	16.3	38.5
733	9.2	54.7	9.6	45.1	6.3	51.7	6.8	14.3	10.7	52.2
734	6.4	46.5	22.4	46.3	-10.0	24.0	6.5	24.0	5.7	34.7
735	7.5	32.1	17.3	32.4	15.9	34.7	15.2	33.2	7.7	36.3
736	6.8	53.3	1.5	67.0	15.7	33.4	7.8	33.3	16.2	41.4
737	14.3	36.7	28.6	37.0	1.3	30.2	3.6	37.0	21.5	44.8
738	15.3	37.6	-10.0	37.1	9.2	25.8	9.6	26.0	6.3	32.1
739	2.8	34.4	1.1	43.3	6.6	43.3	-12.1	32.3	10.2	37.0
740	2.7	32.0	.1	33.3	17.6	41.6	1.6	42.0	11.7	29.6
741	14.0	32.3	7.4	33.6	20.2	46.3	8.7	42.0	11.7	32.0
742	-10.0	40.4	5.5	17.0	.1	24.7	10.7	36.7	22.5	35.7
743	12.5	44.4	10.7	33.5	0.5	30.5	4.2	30.1	15.0	57.1
744	.7	33.5	8.8	31.5	27.4	47.5	11.8	49.0	13.4	40.0

* of DLS

EXPERIMENTAL VERIFICATION PROGRAM, TEST GROUP I-A

FIGHTER BASELINE TEST (CONTINUED)

TEST F-B-2, AIR-TO-GROUND MISSION, DESIGN LIMIT STRESS (DLS) = 30 KSI

745	-0.7	28.1	7.4	35.7	15.6	45.2	4.1	32.8	-1.3	33.5
746	10.4	41.9	5.8	52.8	1.8	26.8	1.1	32.6	21.1	45.5
747	10.7	11.8	1.2	46.5	27.2	50.5	2.1	50.5	2.4	24.8
748	5.4	28.3	13.6	25.8	.6	42.4	9.4	45.8	2.8	29.6
749	13.0	83.3	7.3	39.2	19.0	34.1	-10.0	34.6	2.2	31.4
750	17.5	49.3	21.2	43.2	2.7	45.7	1.5	43.4	2.2	24.1
751	5.3	19.3	-3.9	29.5	14.8	39.6	24.6	53.6	24.8	48.7
752	5.2	65.8	2.2	36.7	5.1	34.0	12.6	36.6	1.6	63.6
753	11.9	24.4	12.8	40.7	-10.0	43.8	13.4	32.8	2.1	42.5
754	4.8	33.8	7.7	18.5	5.4	68.7	9.5	52.6	3.8	57.0
755	25.5	50.2	23.2	23.2	13.1	56.3	38.1	51.6	30.0	54.5
756	18.0	29.3	15.2	43.4	20.9	70.4	14.5	41.1	24.1	58.7
757	10.0	30.3	-10.0	33.3	13.4	32.2	1.5	51.1	13.6	45.3
758	8.4	55.0	11.5	34.6	12.3	66.3	1.2	53.1	27.1	38.8
759	8.6	56.6	24.1	63.3	9.6	33.5	1.4	45.7	12.5	40.2
760	15.0	39.7	5.4	41.8	3.0	25.1	2.4	45.1	.3	37.7
761	-10.0	24.8	5.6	38.6	2.2	20.3	9.0	47.5	1.7	48.5
762	20.4	38.3	5.3	48.1	21.2	51.7	2.5	52.4	33.1	65.5
763	8.2	42.2	7.2	44.8	10.7	40.1	4.2	45.8	3.6	33.4
764	.4	32.6	5.0	44.1	1.4	15.7	-4.4	40.9	-10.0	34.3
765	4.9	23.9	13.7	42.1	4.5	22.1	11.5	35.1	1.1	37.9
766	13.5	26.8	13.7	31.3	11.0	29.7	4.9	40.2	1.4	32.6
767	11.6	37.2	1.1	26.4	3.6	62.7	1.0	33.6	5.2	58.6
768	13.6	44.0	21.7	37.5	6.3	59.3	-13.0	38.4	19.8	43.0
769	2.4	19.2	7.5	33.3	5.9	23.5	11.5	37.5	2.2	32.1
770	4.3	42.9	1.2	45.1	4.8	38.3	20.3	31.1	17.1	42.0
771	13.9	40.4	1.4	37.3	1.1	25.1	6.3	35.4	6.0	28.2
772	11.6	21.3	6.5	42.7	-10.0	55.4	3.6	18.6	1.6	61.4
773	10.5	31.3	14.9	33.4	.5	20.3	8.8	43.7	14.3	29.0
774	1.3	29.7	7.3	30.7	.9	36.6	11.5	23.3	5.0	20.8
775	1.7	17.3	4.1	20.5	8.3	36.0	2.0	36.1	20.3	43.3
776	.1	18.8	-10.0	21.1	4.0	34.4	0.0	11.8	0.0	17.6
777	2.0	34.4	4.0	24.6	9.3	51.0	13.9	33.1	0.0	50.6
778	25.8	38.4	12.1	26.8	.1	51.2	4.2	37.5	12.1	55.1
779	24.2	34.8	22.1	24.1	.9	46.8	31.7	49.2	26.7	23.3
780	-10.0	39.2	22.7	38.9	9.7	31.2	.6	34.0	2.3	48.5
781	0.1	42.3	2.9	20.0	.5	36.4	1.5	39.1	7.4	29.2
782	12.9	33.5	9.9	22.7	-2.2	18.6	3.0	31.8	1.2	36.8
783	-1.3	20.7	22.8	15.7	.2	23.8	4.2	56.0	-10.0	36.6
784	11.0	44.5	2.1	35.8	12.8	44.3	3.3	21.6	1.6	22.0
785	3.8	29.7	7.7	22.5	10.1	26.3	6.4	32.5	1.6	26.1
786	7.8	17.8	1.1	35.0	-1.2	41.3	9.2	22.4	3.2	22.8
787	3.6	28.2	7.8	34.8	1.1	76.2	-10.0	48.5	3.4	35.8
788	5.3	35.0	1.7	24.9	14.4	26.3	11.1	61.6	6.6	21.2
789	5.3	49.8	1.7	21.8	.1	12.0	2.0	45.1	17.5	48.2
790	4.2	56.2	1.6	21.4	4.1	41.5	4.5	18.1	5.5	49.3
791	.9	16.4	1.1	27.5	-10.0	37.3	3.6	28.5	8.5	35.2
792	.3	32.7	5.7	23.3	3.6	18.4	3.4	34.2	1.7	51.1
793	4.6	45.0	7.1	32.9	7.1	19.7	2.7	58.8	15.8	42.6
794	21.7	46.3	13.5	13.8	2.7	18.3	5.4	45.8	11.1	26.8
795	5.7	35.2	-10.0	33.5	12.7	34.7	13.9	28.8	15.4	27.4
796	5.8	22.3	5.5	38.8	.1	40.4	11.3	30.6	2.3	63.4
797	41.0	70.5	23.7	30.3	8.2	23.0	9.9	45.7	22.9	51.2
798	22.8	42.5	12.0	32.6	10.7	31.6	3.3	70.0	29.2	47.4
799	-10.0	45.5	8.2	22.5	9.8	31.6	.8	25.7	3.3	33.8
800	20.3	51.9	4.3	19.1	8.7	19.3	1.8	38.1	11.4	32.8
801	13.8	52.5	2.3	18.3	4.5	42.9	4.1	41.7	5.4	50.4
802	0.0	54.3	1.4	31.1	12.0	47.5	11.4	31.7	-10.0	38.3
803	-3.4	26.4	3.4	42.1	10.3	50.8	2.7	65.4	17.6	57.8
804	14.7	38.5	12.5	35.4	16.5	46.3	3.3	25.8	12.8	48.8
805	15.3	29.3	7.4	37.4	3.8	51.8	5.9	38.8	5.6	48.7
806	2.8	32.3	0.3	66.9	31.4	43.4	-10.0	23.1	5.1	34.4

★% of DLS

EXPERIMENTAL VERIFICATION PROGRAM, TEST GROUP I-A

FIGHTER BASELINE TEST (CONTINUED)

TEST F-B-2, AIR-TO-GROUND MISSION, DESIGN LIMIT STRESS (DLS) = 30 KSI

807	-17.8	43.7	3.2	19.1	3.7	39.4	3.2	45.0	26.0	45.1
808	13.7	23.1	3.2	15.6	13.4	26.1	2.7	25.0	16.0	13.8
809	16.8	35.4	2.0	33.5	12.0	51.5	25.2	43.8	16.0	32.9
810	3.3	13.7	7.3	25.1	-10.0	40.3	2.9	29.6	17.0	57.6
811	1.0	33.3	7.3	40.9	11.8	30.7	9.3	33.6	0.0	58.6
812	17.1	23.5	1.2	33.5	1.7	18.4	7.3	18.7	22.6	28.5
813	14.2	49.6	6.0	23.1	6.7	49.3	6.6	33.7	22.6	35.6
814	1.3	43.0	-1.0	33.6	2.6	13.6	1.7	57.3	36.1	59.2
815	4.2	44.4	1.1	39.1	1.7	48.1	23.6	37.3	4.0	48.2
816	13.3	34.9	7.3	33.2	8.7	36.0	14.7	42.3	17.0	61.5
817	11.8	26.0	8.5	33.7	5.3	36.0	4.3	25.7	1.1	16.2
818	-10.0	23.3	3.3	35.0	0.0	24.6	4.6	76.7	14.3	37.1
819	3.4	33.4	2.1	33.4	12.1	32.3	9.8	58.7	4.0	29.7
820	3.0	35.4	2.5	33.4	12.8	34.4	9.4	25.5	4.0	60.2
821	2.6	48.6	7.4	26.7	9.5	26.9	9.7	35.7	-10.0	23.0
822	1.0	21.5	7.3	33.5	9.5	41.9	8.6	42.3	3.4	30.0
823	1.3	33.3	2.0	44.2	10.2	31.3	4.4	33.8	1.0	29.8
824	1.0	40.8	0.0	43.5	13.6	39.0	1.9	38.0	6.2	36.6
825	18.9	53.3	2.6	22.6	3.2	49.7	-10.0	27.9	4.4	16.1
826	1.3	34.1	7.7	27.6	1.9	32.0	18.9	55.9	12.2	25.8
827	4.4	33.2	2.2	44.7	28.8	44.8	23.8	43.7	11.1	23.1
828	5.5	38.2	4.0	49.2	5.4	19.7	0.7	13.5	-1.0	29.2
829	5.4	63.2	4.0	59.1	-10.0	27.9	0.0	44.9	12.6	32.4
830	6.8	29.9	3.9	20.6	1.5	33.0	-1.7	37.4	12.8	37.3
831	4.6	31.4	1.8	28.7	16.8	40.2	10.3	45.2	4.0	36.8
832	4.4	32.3	1.8	45.5	11.0	52.6	1.5	44.4	1.5	34.4
833	16.8	29.4	-1.0	53.3	3.4	56.8	5.6	29.6	2.1	55.2
834	1.0	25.4	0.0	23.3	4.5	36.1	11.7	52.7	2.0	37.2
835	2.2	41.1	1.0	29.5	2.9	63.2	6.6	23.4	2.0	38.4
836	21.0	45.3	10.3	47.5	13.6	37.6	13.0	56.3	14.3	33.4
837	-10.0	15.4	4.9	45.5	13.5	37.7	4.9	51.2	6.7	22.0
838	11.3	22.2	9.7	53.3	10.5	37.8	0.3	70.0	8.0	28.0
839	11.0	16.2	1.0	43.3	14.2	27.6	26.0	39.2	6.2	38.8
840	5.0	28.0	11.7	70.7	-1.5	36.7	25.0	52.2	-11.0	24.3
841	5.3	36.0	4.5	43.4	23.5	37.9	9.6	37.8	3.0	43.3
842	2.0	49.6	1.6	52.4	1.1	20.9	9.8	24.2	11.9	42.6
843	4.4	24.4	5.4	32.3	1.0	23.2	1.1	22.4	4.1	23.7
844	6.6	24.2	3.3	34.6	6.2	28.4	-10.3	41.2	16.9	37.2
845	13.2	62.3	29.3	53.4	3.1	36.1	7.0	77.3	11.4	40.7
846	8.7	29.1	12.7	40.5	19.7	34.9	8.3	34.1	12.5	31.9
847	1.0	29.7	17.7	31.2	2.2	41.4	22.2	36.8	14.1	30.1
848	1.0	29.2	17.7	31.2	-10.0	41.4	19.1	55.5	14.1	30.1
849	6.8	26.0	10.5	23.6	4.7	26.3	12.7	39.6	20.0	35.5
850	6.2	30.3	11.5	40.1	14.0	44.1	12.3	26.0	12.0	48.1
851	3.4	48.6	12.1	30.0	26.9	40.7	0.0	41.6	4.7	42.4
852	11.2	35.1	-1.0	18.9	2.2	21.9	7.6	39.1	3.1	33.2
853	12.2	29.1	0.0	30.0	20.4	40.7	14.2	33.1	2.6	43.0
854	1.0	30.3	18.5	30.0	3.6	42.0	7.7	29.5	2.1	23.0
855	3.4	38.4	2.2	26.4	23.2	39.4	13.1	31.7	14.1	38.6
856	-10.0	27.0	2.2	49.0	23.2	54.4	4.4	25.7	2.1	54.7
857	0.9	23.2	7.7	33.9	8.0	26.5	9.7	63.7	1.5	19.0
858	0.3	36.6	2.0	34.0	16.1	43.6	2.2	23.7	-1.0	42.0
859	1.4	78.5	22.2	31.0	3.2	38.2	11.4	40.8	-10.0	22.7
860	4.1	50.1	21.3	45.7	3.3	33.9	9.5	36.8	19.0	27.4
861	3.1	38.4	1.2	41.1	21.4	55.0	12.6	66.3	7.7	49.3
862	6.1	27.7	1.4	37.9	1.1	47.8	8.5	30.3	4.0	49.3
863	1.0	24.2	2.2	21.4	3.2	39.8	-10.0	18.4	4.0	49.4
864	4.4	65.7	1.0	45.8	19.3	56.4	3.0	38.4	1.0	32.3
865	2.9	36.4	25.7	55.1	8.6	28.4	13.0	19.4	-1.0	43.3
866	6.6	22.3	8.5	39.3	2.7	27.5	15.3	43.7	1.0	42.3
867	14.4	28.2	1.1	25.5	-1.0	47.7	6.6	24.4	4.0	42.3
868	16.9	35.4	1.2	34.5	1.9	39.0	17.3	31.6	11.3	42.3

* of DLS

EXPERIMENTAL VERIFICATION PROGRAM, TEST GROUP I-A

FIGHTER BASELINE TEST (CONTINUED)

TEST F-B-2, AIR-TO-GROUND MISSION, DESIGN LIMIT STRESS (DLS) = 30 KSI

869	2.5	50.6	14.0	36.2	13.5	59.8	2.5	51.4	2.4	32.2
870	10.0	44.0	5.0	36.0	5.1	37.2	13.4	27.0	2.6	32.2
871	2.5	55.6	-10.0	31.5	5.6	20.7	5.9	34.6	14.2	32.2
872	1.3	36.0	7.6	77.7	15.8	36.4	19.5	67.9	9.1	32.2
873	15.0	35.5	12.3	41.2	24.1	38.7	7.5	21.5	7.5	32.2
874	15.0	56.4	3.2	18.9	7.8	46.7	7.0	49.0	6.3	32.2
875	-10.0	53.2	5.2	25.7	13.6	43.0	13.9	41.1	2.7	32.2
876	2.2	24.0	13.6	25.2	10.7	37.1	1.6	32.5	3.3	32.2
877	2.4	49.2	-1.2	23.2	13.1	36.9	13.6	46.4	27.6	32.2
878	2.2	32.6	14.6	37.6	14.9	40.9	4.0	50.0	-13.3	32.2
879	1.1	20.3	18.1	42.6	11.5	46.4	-1.9	35.8	5.2	32.2
880	1.7	33.4	2.5	47.8	7.7	30.7	7.2	22.0	5.1	32.2
881	4.9	26.7	3.9	38.5	10.0	24.7	14.6	34.2	14.7	32.2
882	1.1	24.9	4.3	51.5	10.6	23.5	-10.0	30.2	2.4	32.2
883	2.1	53.6	14.1	44.2	17.2	43.1	8.4	36.7	20.4	32.2
884	1.4	30.3	5.4	63.5	27.7	41.8	6.2	68.1	4.1	32.2
885	1.5	70.1	4.4	36.9	7.1	48.9	9.9	32.7	54.7	32.2
886	4.2	53.1	3.1	41.4	-10.0	65.1	3.4	37.4	2.4	32.2
887	3.5	50.3	0.0	24.0	5.7	27.1	1.4	24.3	0.9	32.2
888	1.1	17.6	7.0	44.3	6.7	38.0	2.8	32.3	0.0	32.2
889	1.1	31.3	2.1	46.2	12.7	38.0	14.0	52.4	13.7	32.2
890	1.6	21.3	-10.0	36.3	19.0	35.1	8.6	29.6	13.4	32.2
891	3.2	31.1	15.3	30.2	5.1	36.5	1.1	25.6	13.3	32.2
892	3.6	52.4	14.6	52.2	1.1	40.2	-2.0	36.3	10.2	32.2
893	6.2	62.9	-7.7	65.4	13.3	43.4	7.7	47.4	5.1	32.2
894	-10.0	38.2	4.4	45.1	24.0	52.1	2.3	27.3	5.4	32.2
895	1.8	29.1	11.5	35.7	-7.0	22.2	11.1	53.0	5.1	32.2
896	2.7	35.6	10.2	30.4	2.6	44.7	23.5	70.6	1.2	32.2
897	1.4	33.0	21.2	39.4	1.3	29.4	3.9	63.7	-10.3	32.2
898	1.6	43.0	4.3	50.3	2.2	61.6	7.1	46.1	4.3	32.2
899	11.7	54.9	3.3	60.0	22.1	40.3	10.3	34.1	15.5	32.2
900	4.2	25.8	6.1	32.3	7.7	51.7	3.9	39.7	14.4	32.2
901	2.8	31.6	14.5	32.5	16.6	51.9	-11.0	18.4	1.4	32.2
902	13.3	44.1	6.4	11.2	-2.2	22.0	9.0	24.7	0.0	32.2
903	1.1	50.2	9.2	65.9	9.2	26.5	3.0	48.0	3.2	32.2
904	13.1	71.0	5.4	36.7	14.9	54.2	19.7	42.3	22.6	32.2
905	2.2	34.0	1.4	22.0	-13.0	22.7	14.7	28.2	4.4	32.2
906	4.5	26.5	-1.7	24.1	12.5	43.3	5.9	60.0	2.7	32.2
907	2.2	31.1	6.4	24.1	4.4	35.0	-4.8	23.2	2.9	32.2
908	17.4	33.3	6.2	35.4	1.1	48.4	11.4	50.2	10.1	32.2
909	-4.7	37.4	-10.0	42.9	11.0	27.7	15.2	28.0	15.4	32.2
910	1.8	41.5	7.7	45.0	4.8	24.0	9.0	48.0	15.3	32.2
911	15.3	34.3	13.3	37.9	13.6	31.3	0.0	33.2	6.3	32.2
912	12.6	41.2	5.5	17.1	3.4	40.4	27.4	47.5	10.0	32.2
913	-10.0	47.6	2.3	51.2	4.1	31.6	9.1	33.9	11.7	32.2
914	2.2	32.0	0.0	33.2	8.3	31.3	2.7	22.4	2.0	32.2
915	2.9	29.9	-1.1	34.6	15.1	44.8	1.4	50.0	5.0	32.2
916	27.2	64.0	2.3	45.5	10.3	27.6	4.8	30.0	-13.3	32.2
917	1.0	24.9	0.0	33.3	1.2	19.1	9.0	28.0	2.7	32.2
918	2.7	25.0	8.2	32.1	11.1	32.3	9.2	28.0	7.5	32.2
919	1.1	24.5	11.8	36.4	9.9	31.8	7.1	37.7	3.6	32.2
920	1.1	49.0	4.4	34.1	33.9	45.6	-10.0	40.3	1.4	32.2
921	15.0	50.0	2.1	35.7	10.5	61.2	15.1	51.0	17.7	32.2
922	-1.0	20.2	2.3	47.2	10.4	41.5	6.6	16.9	2.0	32.2
923	1.6	47.1	6.2	46.7	15.4	59.4	13.3	52.4	14.5	32.2
924	1.5	42.1	10.5	37.7	-10.0	32.3	4.9	44.2	5.6	32.2
925	8.4	71.7	10.4	39.3	12.9	42.3	6.2	27.4	8.9	32.2
926	4.4	24.4	6.0	37.5	14.8	40.7	12.2	35.0	11.4	32.2
927	10.2	29.9	6.2	51.9	5.7	45.2	10.6	28.8	6.0	32.2
928	5.9	44.5	-10.0	41.1	37.0	61.3	5.4	44.3	17.7	32.2
929	14.1	26.5	4.1	33.9	11.2	50.1	9.2	44.7	17.4	32.2
930	12.0	46.3	27.3	49.9	12.0	25.2	13.3	57.1	2.2	32.2

★ of DLS

EXPERIMENTAL VERIFICATION PROGRAM, TEST GROUP I-A
 FIGHTER BASELINE TEST (CONTINUED)
 TEST F-B-2, AIR-TO-GROUND MISSION, DESIGN LIMIT STRESS (DLS) = 30 KSI

931	25.9	62.4	11.3	37.0	8.5	44.5	14.2	34.5	7.7	45.7
932	-10.0	41.1	1.3	31.6	12.3	46.3	11.2	43.1	1.3	55.8
933	12.4	42.2	12.1	27.2	10.9	37.1	11.1	36.4	12.0	29.8
934	2.0	37.7	17.1	35.8	10.9	46.2	19.1	35.5	2.3	27.8
935	4.4	48.1	10.3	36.0	8.6	21.0	9.0	44.3	-13.9	47.8
936	.1	18.6	1.8	44.5	11.1	29.6	18.2	24.4	2.5	23.9
937	.9	49.4	4.5	25.3	.1	23.9	13.0	48.8	13.6	27.3
938	.4	28.8	10.2	36.2	10.2	40.4	27.2	50.1	11.1	25.1
939	4.3	31.1	8.1	31.6	9.7	44.1	-10.0	59.2	28.4	43.4
940	7.0	18.4	6.6	20.4	4.7	30.9	4.2	40.1	27.1	70.0
941	.4	34.0	20.0	22.0	8.6	73.5	2.9	30.0	-3.5	42.7
942	.3	48.4	18.4	28.4	5.7	35.1	2.4	47.4	17.5	36.7
943	-1.2	34.7	34.8	61.9	-13.0	33.0	2.4	27.4	17.1	38.4
944	7.2	32.1	10.7	46.3	14.1	44.6	6.7	21.6	1.6	44.5
945	.6	37.8	12.3	46.8	.2	49.8	10.6	20.9	4.7	27.0
946	6.2	41.1	16.7	42.3	10.3	52.9	23.1	44.9	3.7	27.4
947	5.4	34.1	-10.0	42.3	13.2	31.9	8.7	37.8	11.4	24.1
948	11.7	40.7	6.7	54.6	2.7	16.7	1.3	44.1	11.5	48.0
949	6.6	42.5	11.0	27.1	-2.2	30.1	19.9	40.1	3.8	47.0
950	4.5	31.5	1.8	47.1	6.7	36.2	14.6	27.1	1.5	42.9
951	-10.0	57.8	5.5	36.7	10.9	31.0	7.9	32.6	3.2	17.7
952	10.9	54.3	5.7	28.3	5.2	36.8	3.6	27.1	1.1	18.2
953	17.5	28.4	1.3	24.5	5.3	45.2	13.0	52.7	1.1	26.8
954	8.0	35.7	17.8	28.6	18.0	40.0	1.0	48.1	-1.1	26.1
955	16.0	38.8	1.3	41.4	9.4	49.2	9.0	36.4	4.2	58.3
956	10.0	24.5	3.4	16.0	5.0	33.5	20.2	36.0	4.9	58.2
957	.4	54.2	26.1	43.3	10.9	46.7	4.7	20.0	3.2	31.6
958	8.0	55.2	20.8	45.5	10.9	56.5	-10.0	31.6	6.5	51.4
959	17.1	28.5	2.0	32.1	7.9	59.2	8.0	45.1	4.1	53.6
960	8.1	44.3	15.8	47.7	5.5	15.0	3.2	28.1	4.7	50.6
961	13.1	29.3	.4	37.4	5.1	37.4	14.9	37.0	4.2	37.7
962	0.0	47.0	10.2	27.2	-10.0	45.0	.7	49.2	21.6	36.6
963	.4	49.6	27.7	48.0	5.0	57.4	26.5	35.5	4.4	55.8
964	.6	21.6	.2	43.0	17.0	29.4	17.6	54.4	26.0	50.8
965	7.6	30.4	5.5	33.1	2.1	24.4	13.1	39.4	15.2	53.7
966	5.2	53.5	-10.0	56.1	5.4	36.7	7.0	26.5	0.0	29.1
967	2.6	30.1	14.2	33.0	9.3	45.5	4.9	29.4	1.2	49.0
968	8.9	31.8	10.1	32.0	15.3	55.4	1.7	25.4	1.2	50.3
969	1.5	63.4	14.8	24.4	4.9	46.7	14.5	34.8	2.7	31.6
970	-10.0	41.4	19.3	29.0	.4	39.6	5.1	32.0	0.0	47.9
971	.5	28.7	3.5	38.1	0.0	31.4	6.2	41.4	11.8	34.6
972	.1	31.1	14.9	36.0	5.6	26.0	9.2	25.7	7.3	32.8
973	-2.1	41.2	17.5	48.7	13.3	44.5	5.7	21.2	-1.0	32.5
974	.9	21.5	11.6	48.0	5.8	64.2	24.4	35.4	.6	57.4
975	10.8	45.6	3.4	43.9	12.3	29.5	15.8	47.5	6.6	50.4
976	13.1	41.2	3.5	31.2	19.0	34.3	15.8	47.5	22.4	54.0
977	5.6	48.5	13.4	70.0	1.7	21.7	-10.0	60.4	22.0	25.2
978	1.3	43.4	6.8	26.4	12.7	39.5	5.4	19.5	6.6	57.7
979	5.4	44.5	1.1	26.4	13.8	47.1	3.0	22.1	5.5	58.1
980	14.7	56.2	14.4	55.9	12.4	28.1	12.4	33.4	22.0	37.2
981	5.0	47.7	10.1	35.5	-10.0	35.7	25.2	37.2	21.5	56.4
982	11.1	57.1	3.1	44.8	2.5	42.5	17.7	32.1	14.7	28.2
983	2.4	39.4	8.0	37.3	14.9	44.0	3.1	49.8	17.6	47.6
984	18.1	37.2	18.3	45.1	4.8	23.7	3.2	38.0	7.5	24.7
985	.6	17.1	10.0	47.3	10.6	63.8	3.2	35.5	5.5	45.7
986	14.7	26.5	3.5	24.0	4.0	66.2	-1.8	35.7	7.5	30.6
987	10.0	20.9	4.4	45.5	11.5	34.4	13.9	28.7	7.7	51.6
988	14.0	29.6	1.0	46.5	3.9	21.2	10.7	48.5	9.6	24.7
989	-10.0	31.8	4.3	43.7	2.2	13.3	0.0	43.5	10.0	61.4
990	.1	41.5	.5	43.3	13.7	30.7	1.0	53.3	2.4	25.2
991	9.3	21.3	10.3	29.0	12.8	70.0	1.0	27.2	2.0	45.4
992	18.3	48.9	4.2	24.2	12.6	32.5	1.1	39.5	-10.0	71.0

★ of DLS

EXPERIMENTAL VERIFICATION PROGRAM, TEST GROUP I-A

FIGHTER BASELINE TEST (CONCLUDED)

TEST F-B-2, AIR-TO-GROUND MISSION, DESIGN LIMIT STRESS (DLS) = 30 KSI

993	42.3	32.9	4.1	26.4	7.9	42.7	8.6	30.8	13.8	33.7
994	13.4	26.1	7.7	53.7	9.6	56.6	1.2	34.5	16.9	42.8
995	4.4	40.3	.5	35.4	17.1	48.7	.3	57.7	31.8	44.0
996	15.7	42.4	4.0	24.9	9.9	24.7	-10.0	45.2	24.6	47.6
997	4.9	20.3	1.9	7.2	10.9	38.7	8.6	36.6	14.8	25.0
998	12.5	45.6	4.9	18.3	0.0	33.5	1.7	28.9	6.0	48.1
999	1.3	30.4	4.2	27.3	-1.1	22.6	7.8	59.0	.2	19.5
1000	.8	47.6	13.3	23.4	-10.0	0.0	0.0	0.0	0.0	0.0

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